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Research Natural Areas

in Colorado, Nebraska, North Dakota, South Dakota, and Parts of Wyoming

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Abstract

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The purpose of the Research Natural Area system is to provide a representative range of undisturbed sites for research, monitoring, biodiversity protection, and as reference areas for management activities on public lands administered by the USDA Forest Service. This publication describes the location, significant features, climate, flora, fauna, and published research for the 16 Research Natural Areas established through 1993 on Public Lands administered by USDA Forest Service in Colorado, Wyoming, Nebraska, North Dakota and South Dakota.

Keywords: Research Natural Areas, biodiversity, monitoring, Colorado, Wyoming, Nebraska, North Dakota, South Dakota

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INTRODUCTION

Research Natural Areas (RNAs) are lands that are permanently protected for the purposes of maintaining biological diversity, conducting nonmanipulative research, monitoring to determine the effects of management on similar ecosystems, and fostering education. The national network of RNAs is designed to represent ecosystems found on public lands administered by USDA Forest Service, National Forest Systems, and also to conserve unique assemblages of species or communities of scientific interest. In RNAs throughout the country, natural conditions are allowed to prevail by limiting human intervention. Other federal agencies that manage public lands (for example, USDI National Park Service, USDI Bureau of Land Management, USDI Fish and Wildlife Service) also establish RNAs and participate in developing the national RNA network.

The first RNA, Santa Catalina RNA in Arizona's Coronado National Forest, was established in 1927. The 250th, LaRue-Pine Hill/Otter Pond RNA in Illinois, was established in 1991. Throughout the intervening 64 years, RNAs have helped the USDA Forest Service achieve its mission.

From the USDA Forest Service Manual (FSM 4063.02), the objectives of establishing an RNA are:

1) To preserve a wide spectrum of pristine areas that represent important forest, shrubland, grassland, alpine, aquatic, geological, and similar natural situations that have special or unique characteristics;
2) To preserve and maintain genetic diversity;
3) To protect against serious environmental disruptions;
4) To serve as reference areas for the study of succession;
5) To provide on-site and extension educational activities;
6) To serve as baseline areas for measuring long-term ecological changes;
7) To serve as control areas for comparing results from manipulative research; and
8) To monitor effects of resource management techniques and practices.

Researchers from the USDA Forest Service and elsewhere use RNAs for studies that do not modify natural conditions. The research and monitoring done on RNAs, in turn, allow RNAs to serve as controls for managed forest and rangeland ecosystems.

Currently there are 16 RNAs on public lands administered by the USDA Forest Service in Colorado, Wyoming, Nebraska, North Dakota, and South Dakota, the northern portion of the territory covered by the Rocky Mountain Forest and Range Experiment Station (fig. 1). The size, location, primary vegetation, and date of establishment for these RNAs are given in table 1. Unfortunately, these 16 RNAs represent only a small fraction of the diversity of plant communities found in the region and, to date, have been sparsely used for research. Additionally, many of the existing RNAs have no baseline ecological information to document existing conditions and to allow researchers to assess natural change over time.

We hope that this publication will aid researchers interested in studying natural communities and encourage research on the region's RNAs. The objectives of this publication are to: (1) describe the procedure for doing scientific research on RNAs, (2) describe the potential role of RNAs in ecosystem management and the current management of RNAs, (3) briefly describe the RNA program in the northern portion of the territory covered by the Rocky Mountain Forest and Range Experiment Station, and (4) present a summary of the information available for each established Research Natural Area. The information for each RNA includes location and access, a short overview, and capsule summaries of physiog-

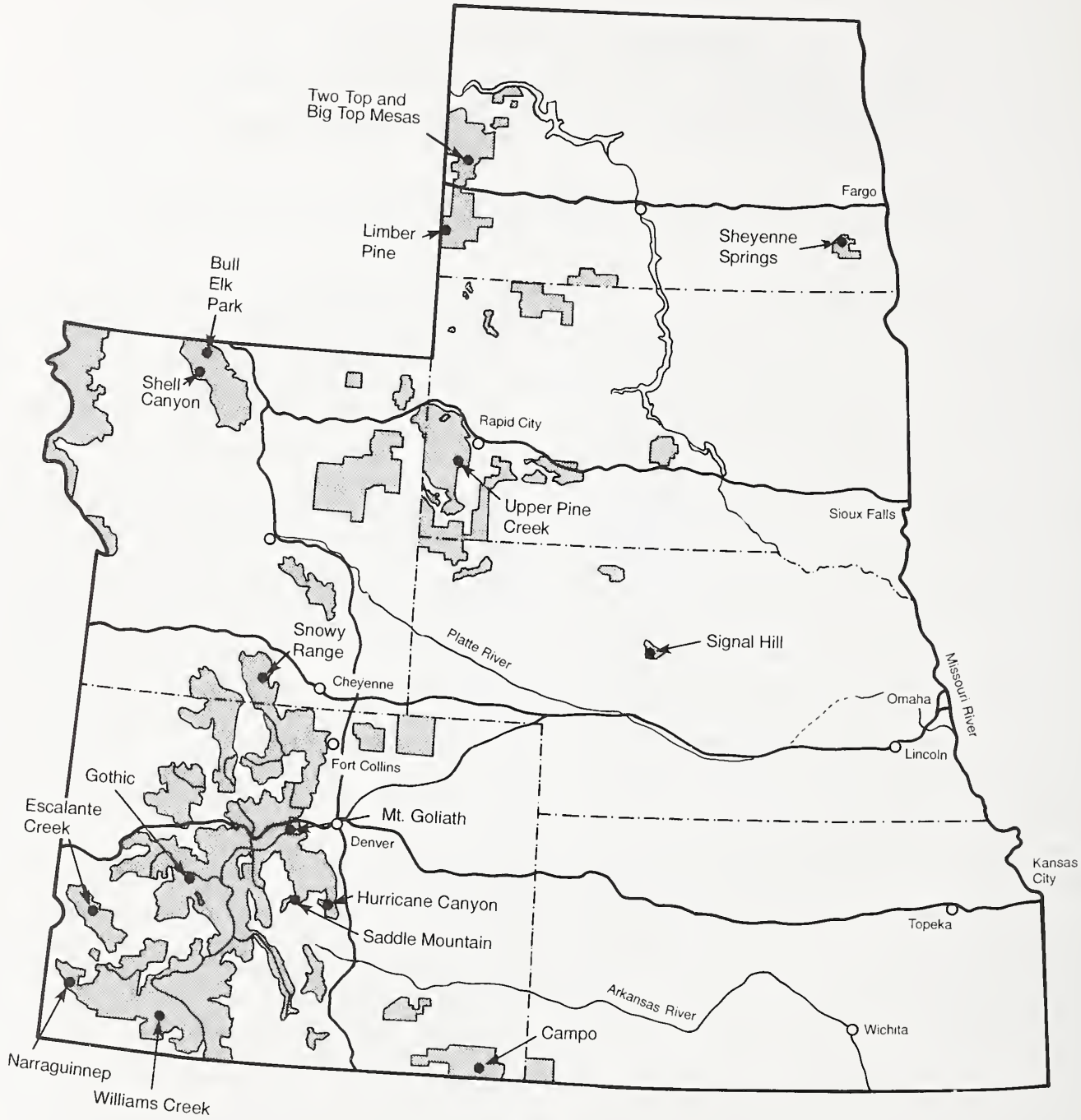

Figure 1. — Location of RNAs in Colorado, Wyoming, Nebraska, North Dakota, and South Dakota. Shaded areas are public lands administered by USDA Forest Service.

raphy, geology, soils, flora, and fauna of each RNA. In addition, the entry for each RNA lists status and administration information and any publications that have resulted from scientific work done on the RNA.

The information contained in this publication was taken from original establishment records for the RNAs, as well as reports on site visits and other material on file at the Rocky Mountain Forest and Range Experiment Station in Fort Collins, Colorado. In cases where scientific or common names within the individual files were missing or incomplete, Armstrong (1987), Behler (1979), Great Plains Flora Association

Table 1. — Location, primary vegetation type, size, and date established for RNAs on National Forest lands in Colorado, Nebraska, North Dakota, South Dakota, and parts of Wyoming.

Name	Location (national forest, ranger district, state)	Primary vegetation	Area (ha)	Date established
Bull Elk Pork	Bighorn NF, Tongue RD, Wyoming	Lodgepole pine - montane grosslond	291	1952
Compo	Pike ond Son Isobel NFs, Comanche Nationol Grosslond, Corrizo ond Timpas Units, Colorodo	Shortgrass prairie, blue-gromo, buffalo-gross	14	1987
Escalante Creek	Grond Meso, Uncompohgre, and Gunnison NFs, Ouroy RD, Colorodo	Blue spruce riporion oreo	18	1985
Gothic	Grond Meso, Uncompahgre, ond Gunnison NFs, Toylor River RD, Colorado	Spruce-fir and alpine	425	1931, 1959
Hurricone Conyon	Pike ond Son Isobel NFs, Pikes Peok RD, Colorado	Ponderoso pine, Douglos-fir	211	1931
Limber Pine	Custer NF, Little Missouri Notionol Grasslonds, Medoro RD, North Dokoto	Limber pine, ploins shrublond, ploins grassland	276	1991
Mount Golioth	Aropoho ond Roosevelt NFs, Clear Creek RD, Colorodo	Bristlecone pine	65	1950
Norroguinnep	Son Juon NF, Dolores RD, Colorodo	Ponderoso pine, pinyon-juniper	781	1932, 1962
Soddle Mountoin	Pike ond Son Isobel NFs, South Pork RD, Colorodo	Montone grosslond, aspen, Engelmonn spruce	194	1951
Shell Conyon	Bighorn NF, Pointrock RD, Wyoming	Rocky Mountoin juniper	295	1987
Sheyenne Springs	Custer NF, Sheyenne Notionol Grosslond, Sheyenne RD, North Dokoto	Wetland complex	23	1992
Signol Hill	Nebrasko NF, Bessey RD, Nebraska	Sandhills grosslond	283	1950
Snowy Ronge	Medicine Bow NF, Loromie RD, Wyoming	Spruce-fir, lodgepole pine	312	1936
Two Top and Big Top Mesos	Custer NF, Little Missouri National Grosslands, Medora RD, North Dokoto	Mid-grass prairie	32	1973
Upper Pine Creek	Block Hills NF, Harney RD, South Dokota	Ponderoso pine	482	1931
Willioms Creek	Son Juon NF, Pogoso RD, Colorado	White fir	220	1987

(1986), Scott (1987), Weber (1976), Welch et al. (1987), and Whitaker (1980) provided species information. Soil classification is given as listed in the establishment records; we did not update soils information with the new taxonomy.

The climate information for the RNAs was taken from the nearest NOAA weather station that recorded both temperature and precipitation. Because the RNAs are usually in remote areas with rugged terrain, these nearby weather stations often poorly reflect the actual climate at the RNA. Climate data were plotted using a suggestion by Walter (1973) where the ordinate represents either 20 mm of precipitation or 10°C of temperature. With this scheme, when the line that represents average monthly temperature is greater than the line that represents average monthly precipitation, the site experiences drought conditions.

Research Natural Area Program in the Northern Portion of the Rocky Mountain Forest and Range Experiment Station

Overview

The purpose of the RNA system is to provide a representative range of undisturbed sites for research, monitoring, biodiversity protection, and as reference areas for management activities on public lands administered by the USDA Forest Service. Toward this end, several tools have been developed to aid establishment and use of RNAs. These include:

1) A matrix of plant communities proposed for inclusion in the RNA system, together with the location of these communities on national forests and grasslands.
2) Criteria for RNA selection.
3) RNA Management Area Prescription.
4) Procedures for establishing RNAs, and samples of documents necessary for establishment, including an Ecological Evaluation, an Establishment Record, and Ecological Assessment.

These documents have been assembled into the Research Natural Area Guide for the Rocky Mountain Region. Both the guide and sample documents are available from:

Research Natural Area Coordinator
Rocky Mountain Forest and Range
Experiment Station
240 West Prospect Road
Fort Collins, CO 80526-2098
(303) 498–1100

Management of Research Natural Areas

RNAs are managed according to RNA management area prescriptions contained in Forest Management Plans. These prescriptions call for maintaining the area in as near a pristine state as possible. Logging, new roads or trails (except to correct resource damage), and developed recreation are prohibited, as is any manipulative research. Grazing is permitted only to maintain the natural vegetation. Fires are allowed to burn in RNAs, unless they endanger the RNA or threaten persons or property outside the RNA. No action will be taken against endemic insects, diseases, or wild animals. Further information about the management of RNAs and a sample management area prescription can be found in the Research Natural Area Guide for the Rocky Mountain Region.

The Role of Research Natural Areas in Ecosystem Management

Ecosystem management is an evolving approach to resource management within the USDA Forest Service (Robertson 1992) and other land management agencies. One definition of ecosystem management is the management of biological, physical, and human components and processes of ecosystems in ways that maintain sustainable ecological processes, biodiversity, environmental quality, and the production of resource commodities and amenities (Agee and Johnston 1988, Estill and Montrey 1992, Jensen and Bourgeron 1993). Ecosystem management integrates ecosystem components, processes, and resource uses (Salwasser 1992a, 1992b; USDA Forest Service 1992a). Ecosystem and social sustainability are the cornerstones of a holistic approach to ecosystem management (Estill and Hemstrom, 1993; Overbay 1992; Rowe 1992).

Biodiversity and biological processes occur at genetic, species, population, community, ecosystem, landscape, and regional scales and need to be managed over a variety of spatial and temporal scales (Franklin 1992, Noss 1983). Ecosystem sustainability requires the maintenance of the diversity of plant and animal species and natural processes such as succession, disturbance, and evolution (Agee and Johnson 1988; Estill and Hemstrom, 1993). Combining this requirement with the necessity of producing wood, forage, water, and recreational opportunities is often a challenge and occasionally a conundrum. Some areas of National Forest System lands have departed significantly from their natural condition (Franklin 1992, Noss 1987b). "Natural," like the word "ecosystem," has many potential meanings. For our purposes, natural condition will mean presettlement or our estimate of the condition that an ecosystem would be in if settlement by people from Europe, Asia, and Africa in the last several centuries had not occurred—ecosystems with relatively intact evolutionary relationships (Hoerr 1993, Maser 1990). Some lands have been through many timber rotations, planted with monocultures of genetically similar trees, or grazed by domestic livestock for decades. Some lands have been invaded by nonnative weed species, while others are heavily impacted by recreation. Many of these departures from a natural condition occurred on lands before they became a part of the National Forest System. As human demands increase, fewer examples of natural ecosystems remain, and some

managed lands retreat further from their natural condition (Moir 1972, Noss 1987b, Odum and Odum 1972).

To reduce the risk associated with our limited knowledge and to insure ecosystem health, diversity, and sustainability, it is prudent to manage some ecosystems within their range of natural variability (Estill and Hemstrom, 1993; Jensen and Bourgeron 1993). It is difficult to determine the range of natural variability without reference to areas such as RNAs, which are relatively undisturbed by humans.

RNAs as Benchmarks

Many management activities on National Forest System lands can be thought of as experiments. The outcome of these experiments in boardfeet, animal unit months, or public satisfaction is often well known. However, many important phenomena, including changes in vegetation, animal populations, soil quantity and quality, plant susceptibility to insect and disease epidemics, and changes in future productivity, are often incompletely understood (Franklin 1992).

If Forest Service management is an "experiment," then reference points are necessary to evaluate the success of the experiment. This function of being a reference or benchmark is one of the principal values of RNAs, which are among the least modified sites on Forest Service lands (Loop 1986, Tippets 1990, USDA Forest Service 1992b). Whether we want to monitor site productivity, soil loss, populations of small mammals, neotropical bird migrants, indicator species, the health of endangered species populations, nutrient cycling, amounts of coarse woody debris, or the impacts of road density on elk populations, reference points are necessary. In Forest Service monitoring, standards to which managed lands can be compared will often be essential.

As an example, on a Forest Service allotment in the Southwest it was argued that obvious gullying and erosion were more the result of weather and fragile soils than of cattle grazing. A designated natural area with similar fragile soils, climate, and vegetation, but no recent livestock grazing, provided a reference, showing that the grazed lands had erosional rates and vegetation loss far outside the range of natural variability. Livestock grazing regimes have economic, cultural, and political, as well as biological, consequences. Yet, without a firm grasp of ecological reality, which RNAs can often provide, the environmental analysis required by NEPA may rest on a poor foundation, ecosystem sustainability may diminish, and the future needs of society may not be met.

The RNA System

Wilderness, special interest areas, RNAs, and other natural areas can all help provide the references necessary for management and environmental analysis. Among these, the Research Natural Area system is unique because of its goal of providing high quality, relatively pristine, representative examples of the full range of ecosystem types that occur on National Forest System lands. To be useful for management comparison, the RNA system should include good examples of the most productive lands in the National Forest System.

Ideally, the RNA system should represent a substantial portion of the variability in national forest ecosystems, including variability in biota, landforms, geology, soils, climate, successional stages, disturbance regimes, and other ecological processes. Since the variation in plant communities often reflects other forms of biotic and abiotic variation (Daubenmire 1976, Pfister and Arno 1980), plant communities have been chosen initially for defining the RNA system. These communities have been identified at the plant association, plant series, or higher plant community levels by most regions. Advances in Forest Service hierarchical ecological maps, Integrated Resource Inventories, and GIS systems will help refine the RNA system, measure its representativeness, and make it more valuable as a comparative tool in ecosystem management.

Research Natural Areas need to be large enough to encompass a mosaic of successional stages and disturbance patterns, as well as a wide range of biotic and abiotic variability. Large size will help maintain natural processes and viable animal and plant populations and minimize deleterious edge effects. Research in conservation biology has shown that the integrity and value of natural areas increases significantly with size (Baker 1992, Noss 1987b, Saunders et al. 1991, Soule and Simberloff 1986).

RNAs as Research Sites

Closely related to the important function of RNAs as reference areas is their availability as sites for scientific research. Ecosystem management implies an understanding of how ecosystems operate (Salwasser 1992a). Unfortunately, our understanding of ecosystems and how humans affect and are affected by ecological processes is fairly rudimentary. RNAs can serve as sites to investigate the functioning of ecosystems in landscapes and the sustainability of both ecosystem processes and community components.

Plant and animal species have evolved adaptations to each other and to their environment, which are expressed in complex patterns of succession, predation, herbivory, parasitism, pollination, dispersal, and survival. These biological relationships, in turn, are influenced by patterns of natural disturbance, geomorphic processes, and climate change. Because species and their complex interactions have evolved and continue to evolve in natural ecosystems, they are best studied in areas that have undergone minimal human disturbance (Bildstein and Brisbin 1990, Moir 1972). We also know that some of our "natural" ecosystems have been influenced by thousands of years of human disturbance, such as the burning of grasslands by Native Americans (Hoerr 1993). This knowledge will influence our management of some RNAs and other National Forest System lands.

The RNA system is intended to include the full array of terrestrial and aquatic ecosystems for the scientific research necessary for ecosystem management. RNAs provide an opportunity for studying the same ecological process over a range of ecosystem types. Baseline data and long-term ecological research on RNAs will provide an important body of information for land and water management. These data and research from RNAs will be useful for cumulative effects analysis on similar managed ecosystems and for investigating the impacts of global climate change (Franklin 1992). RNAs are great natural libraries, "unconditional gifts of potential knowledge for the future" (Maser 1990).

Scientific information from RNAs can change our basic understanding of ecological processes and offer important guidance for ecosystem management. As an example, old-growth forests have been previously characterized as decadent stands with little productivity. Permanent plots dating from the 1930s on an RNA in the Pacific Northwest have documented that some old-growth forests have much higher levels of productivity than previously thought possible. In the increasingly complicated times ahead, scientific research on minimally disturbed ecosystems will be essential to the task of successfully managing National Forest System lands.

RNAs as Sites for Biodiversity Protection

The protection of biodiversity is an important goal of ecosystem management (Estill and Hemstrom, 1993; Salwasser 1992b). RNAs and other protected natural areas harbor only a small portion of the total biodiversity on National Forest System lands. Nevertheless, a system of RNAs, composed of the best remaining examples of most ecosystem types, is a significant contribution to biodiversity protection in its own right. Because we know so little about the diversity of nonvascular plants, soil microflora and fauna, terrestrial and aquatic invertebrates, and many other elements of biodiversity (as well as the complex relationships and processes that connect them) (Brussard 1991), the RNA system helps provide a safety net, a form of insurance against the loss of species and biotic communities. This is an important aspect of a coarse filter approach to protecting biodiversity (Hunter 1991).

Additionally, many RNAs offer protection for populations of threatened, endangered, and sensitive species and for rare and sensitive plant communities and animal habitats (the fine filter approach) (Hunter 1991). In California alone, more than 132 rare plant species are found on Forest Service RNAs (Keeler-Wolf 1990). RNAs can provide benchmarks for evaluating the success of biodiversity protection on National Forest System lands and help meet some of the legal obligations for protection and monitoring required by the National Forest Management Act, the National Environmental Policy Act, and the Endangered Species Act (USDA Forest Service 1990).

RNAs are embedded in a matrix of lands with many different management prescriptions. Within the larger managed landscape, some RNAs may function as core areas for the maintenance of genetic diversity and sensitive species, or, in a few circumstances, an individual RNA might serve as a corridor for dispersal and migration of some plant and animal species (Crow 1991; Noss 1987a, 1987b). RNAs are not isolated units; they are integral parts of a landscape mosaic which needs to be managed as a whole. The surrounding landscape will occasionally need to be managed to insure the integrity of RNAs. Coordination and cooperation across ownership boundaries may be necessary to help insure this integrity. RNAs are generally a direct benefit to biodiversity at most of the spatial and temporal scales implicit in ecosystem management.

RNAs in Forest Planning

RNAs can contribute to the land and resource management planning process by providing models for some of the landscape features the Forest Service would like to include, extend, or restore. Information provided by RNAs can help achieve desired conditions on most National Forest System lands. By

identifying sites that fill gaps in the RNA system and by developing management plans for RNAs, national forests and grasslands can make valuable contributions to ecosystem management. RNAs will also provide useful tools for helping to insure that Forest Service management activities meet the environmental requirements of the law. Ecological research, of the kind performed on RNAs, needs greater recognition for its importance to society and as one of the significant multiple-uses of public lands.

RNAs in Conservation Partnerships

Developing constructive partnerships is a tenet of ecosystem management (Agee and Johnson 1988, USDA Forest Service 1992a). Many individuals and organizations have a great interest in RNA programs, including state Natural Heritage and Natural Areas programs, The Nature Conservancy, Native Plant Societies, many academic institutions, and the scientific community at large. Conservation partnerships with these diverse parties have been of mutual benefit to both the public and the Forest Service. Statewide conservation planning, in which Forest Service RNA programs play a key role, can forge effective working partnerships between government agencies, private organizations, and the scientific community (Department of Natural Resources 1987, Loop 1986). RNAs can be effectively used as interpretive and educational tools to demonstrate the scientific basis for land management and to increase dialogue with the public. Within the Forest Service, RNAs provide an important bridge between the concerns of research and National Forest Systems.

In the future, Research Natural Areas will be one of the more useful tools available to the Forest Service for improving and evaluating the success of ecosystem management. Because of the multiple purposes they serve and the important biodiversity and ecosystem processes they harbor, RNAs have high value for present and future generations.

Conducting Research on RNAs

The use of RNAs for research is encouraged because research activities will help us better understand natural processes. Additionally, research data, while limited in scope, will help provide baseline or background information useful for assessing change in the future. Research must be "nonmanipulative" and "nondestructive." That is, research must not disrupt either the community structure or populations of individual species of plants or animals. Research also must not alter the biogeochemical functioning of the ecosystem.

What are Appropriate Research Activities on RNAs?

Disturbance caused by research is a concern because we do not want research activities to change these ecosystems. However, for RNAs to serve as controls for managed ecosystems, some sampling is required. The disturbance caused by research might be ranked along a continuum from effectively no disturbance to activities that could alter organism populations and ecosystem function. For example: satellite observations < aerial observations < walk-through survey < frequent walk-through surveys < permanent plots (tagged trees, etc.) < sample collection (herbarium samples; soil, water, foliage samples for chemical analysis; tagging and releasing insects, birds, or mammals; coring trees) < harvesting (understory plots; trees; insect, bird, or mammal collections; extensive soil sampling (soil pits)) < manipulating ecosystem resources (water, nutrients, light, temperature) < manipulating populations (herbicide, insecticide, or fungicide application; large-scale harvesting).

While it is easy to decide the permissibility of activities at both ends of the continuum (experimental manipulations are forbidden), activities in the middle are problematic. Decisions about whether an activity is appropriate will consider:

1) Size of the RNA or feature of the RNA (a more diffuse sample will likely have less impact).
2) Whether the activity (collection or census) is to be done to a rare, sensitive, threatened, or endangered species.
3) Frequency of the activity.

In general, where RNAs serve as representative controls, small sample collections (herbarium samples; soil, water, foliage samples for chemical analysis; tagging and releasing insects, birds, or mammals; coring trees) and permanent plots should be permitted and encouraged. Where RNAs contain unique features, special care must be taken not to disturb these features.

Permission

Permission for research on RNAs should be obtained from the RNA Coordinator for the Rocky Mountain Forest and Range Experiment Station (for-

mally, the station director), and the district ranger where the RNA is located. If the RNA is located in a designated wilderness area, research use of the area must also be approved by the regional forester.

Responsibilities of Researchers

Anyone conducting research on RNAs must:

1) Request permission from the Rocky Mountain Forest and Range Experiment Station RNA Coordinator with a short (1-page) proposal or letter outlining the research activity, proposed sampling, and frequency. The RNA Coordinator will forward the request to the appropriate district ranger after determining that the proposed research is appropriate for the RNA.
2) Submit a summary of the collected data at the end of the field portion of the study to the Rocky Mountain Forest and Range Experiment Station. Or, if the length of the study exceeds 5 years, submit a summary of the collected data after every 5 years to the Rocky Mountain Forest and Range Experiment Station. Data collected will become part of the permanent record on the RNA and aid future researchers.
3) Submit copies of any reports or publications using data collected in the RNA to the Rocky Mountain Forest and Range Experiment Station and the district ranger.
4) Take care to keep sampling and disturbance minimal and unobtrusive. Remove any research materials at the end of the study.
5) Personally contact the district ranger before initiating field work.

For More Information

Scientists interested in obtaining permission to conduct research on a Research Natural Area on National Forest Lands in Colorado, Wyoming, Nebraska, North Dakota, and South Dakota should contact:

Research Natural Area Coordinator
Rocky Mountain Forest and Range
Experiment Station
240 West Prospect Road
Fort Collins, CO 80526–2098
(303) 498-1100

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BULL ELK PARK RESEARCH NATURAL AREA

Location

Bull Elk Park RNA is located 10 miles northwest of Burgess Junction, Sheridan County, Wyoming, in the Tongue Ranger District of the Bighorn National Forest. The RNA occupies portions of sections 19, 20, 29, 30, and 31 of Township 57 North, Range 89 West, Sixth Principal Meridian.

To reach the RNA from Burgess Junction, Wyoming, take Forest Road 15 (the Burgess road) northwest, then west for approximately 17 miles to the junction with Forest Road 147. You can take this four-wheel-drive road to the right for about 2 miles; from this point, the RNA is accessible only via a moderate 4-mile hike on Trail #76 (fig. 1).

Overview

The 291-hectare Bull Elk Park RNA was created in 1952 to protect Bull Elk Park proper, an 81-hectare grassy park (fig. 2) surrounded by lodgepole pine, typical of the grassland types that cover much of the tops of the high plateau country of northern Wyoming's Bighorn Mountains. The park lies near the end of a long point that extends in a northeasterly direction toward the junction of Lick Creek and the Dry Fork of the Bighorn River and is almost isolated by three canyons. The only point of access is a very narrow ridge that connects the area to the main mass of the Bighorn Plateau. Because of its isolation, the park has never been grazed by domestic livestock and contains an excellent segment of pristine grassland vegetation that is grazed by elk (*Cervus elaphus*) in the spring and summer.

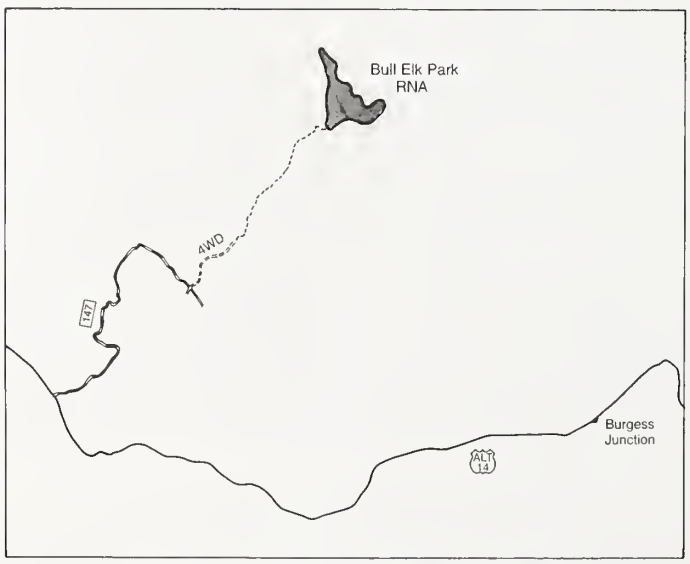

Figure 1. — Location of Bull Elk Park RNA.

Climate

Climate for a weather station near Bull Elk Park is summarized in figure 3. The average annual precipitation on the RNA is 528 millimeters, of which nearly 60% falls during the April to September warm period. The average annual temperature is 0.6 °C. Average dates for the last killing frost range from June 10–June 20. The earliest killing frost usually occurs around August 30.

Physiography, Geology, and Soils

The RNA is a part of the northern plateau of the Bighorn Mountains. Its topography is dominated by a rolling, dissected plateau, with altitudes ranging from 2134–2286 meters above sea level. Bull Elk Park proper is a grassy bald that is almost isolated from the rest of the Bighorn Plateau by three deep, steep-walled canyons. The park is bisected by a low ridge that extends its entire length. This band of outcrops indicates that the soil is derived from limestone and shale. Along these outcrops, the soil is shallow, and plant cover is sparse. In most of the area, however, the soil is very deep and consists of Lake Creek and Lick Creek loams, with high organic content.

Flora

The 1951 establishment record termed the area's dominant cover type to be "northern mountain grassland." The park is a disjunct of the Palouse Prairie Climax, or the *Agropyron-Festuca* association, which extends through Montana, deep into British Columbia, eastern Washington, northern Utah, and northwestern Colorado.

Bluebunch wheatgrass (*Agropyron spicatum*) is common on shallow rocky soils at slightly lower eleva-

Figure 2. — Bull Elk Park RNA (courtesy of the Tongue Ranger District).

tions. Two other characteristic dominants are Idaho fescue (*Festuca idahoensis*), which dominates the dry ridgetop, and spike fescue (*Leucopoa kingii*). The latter, which occurs in dense, scattered patches, is a characteristic dominant of the portion of the association that occurs in northern Wyoming. Other common associated grasses are smooth brome and mountain brome (*Bromus inermis* and *B. carinatus*), Nelson needlegrass (*Stipa nelsonii*), timber oatgrass (*Danthonia intermedia*), and big bluegrass (*Poa ampla*). Blue wildrye (*Elymus glaucus*) occurs around the edges of the park, and slender wheatgrass (*Agropyron trachycaulum*) and bearded wheatgrass (*A. trachycaulum* ssp. *glacum*) are also present.

Some of the more common forbs are yampa or false yarrow (*Perideridia gairdneri*), lupine (*Lupinus* sp.), mountain dandelion (*Agoseris* sp.), yarrow (*Achillea millefolium* ssp. lanulosa), geranium (*Geranium* sp.), cinquefoil (*Potentilla* sp.), northern bedstraw (*Galium boreale*), harebell (*Campanula* sp.) and asters and fleabanes. Woody plants include snowberry (*Symphori-*

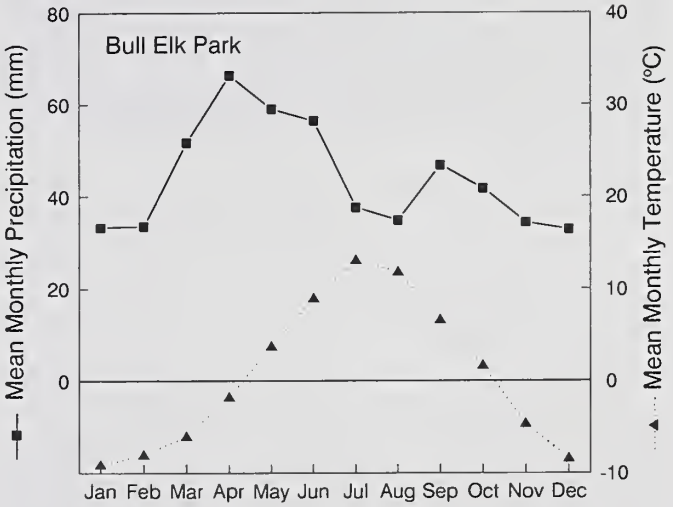

Figure 3. — Long-term average of monthly temperature and precipitation (from NOAA records) for the weather station closest to Bull Elk Park RNA. Data were taken from the Burgess Junction, CO, weather station, which is at an elevation of 2450 meters. The elevation of the RNA ranges from 2135–2285 meters, so actual climate at the RNA will likely be quite different than that shown. Precipitation and temperature were averaged over 32 years.

carpos sp.), which is rarely more than a few inches high—presumably because of browsing by elk—as well as some shrubby cinquefoil and prostrate juniper. Sagebrush (*Artemisia* sp.), a common associate throughout this type, is not abundant here.

The *Agropyron-Festuca* association may be subclimax to the conifer timber type in this location. This Wyoming portion of the type represents its most easterly extension and is unique in that spike-fescue is present. Relict areas of appreciable size that are completely unmodified by domestic livestock grazing are very rare. The nearest known like areas are in Yellowstone National Park. Aside from Bull Elk Park proper, the entire area of the RNA is lodgepole pine (*Pinus contorta*) forest.

A part of this forest was destroyed by the 1947 Bull Elk Park fire, which burned south of the park but was stopped at its southern boundary when it encountered the moisture of the tall grass and deep, damp organic layer.

Fauna

The principal big game species are elk and mule deer (*Odocoileus hemionus*). Wapiti graze the park in the spring and summer. Black bear (*Ursus americanus*), mountain lion (Felis concolor), and coyote (*Canis latrans*) inhabit the general area. No year-round streams or lakes are present in this area; wildlife can obtain water at a small intermittent spring in the center of the park or at a permanent spring located in a small forest opening near the park's eastern edge.

Status and Administration

Bull Elk Park is managed under special management prescription 10A under the Bighorn National Forest Plan. The Tongue River Ranger District (Sheridan, WY 82801, 307-672-0751) has responsibility for administration and protection of the RNA.

For information on conducting research on the RNA, contact:

Research Natural Area Coordinator
Rocky Mountain Forest and Range
Experiment Station
240 West Prospect Road
Fort Collins, CO 80526-2098

Research

We found only one published study on the RNA (Probasco 1968). Lorin Word, retired wildlife biologist, USDA Forest Service, conducted research on the habitat needs of elk near, but not on, the RNA in 1968.

Publications

Demorest, M.H. 1941. Critical structure features of the Bighorn Mountains, Wyoming. Geological Society of America Bulletin. 52: 161–176.

Johnson, J.L.; Pfister, R.D. 1982. A survey of potential ecological natural landmarks of the middle Rocky Mountains. Ogden, UT: U.S. Department of Agriculture, Intermountain Forest and Range Experiment Station.

Hurd, R.M.; Kissinger, N.A., Jr. 1952. Range investigations, Bighorn National Forest, Wyoming. Paper No. 10. Fort Collins, CO: U.S. Department of Agriculture, Rocky Mountain Forest and Range Experiment Station. 24 p.

Probasco, G.E. 1968. Diet preferences and utilization patterns of elk in the northern Bighorn Mountains, Wyoming. Laramie, WY: University of Wyoming. M.S. thesis.

CAMPO RESEARCH NATURAL AREA

Location

Campo RNA is located approximately 3 miles south of the town of Campo along U.S. Highway 287-385 in far southeastern Baca County, Colorado, 4.5 miles north of the Oklahoma border and about 30 miles west of the Kansas border. The RNA is part of the Carrizo and Timpas Units of the Comanche National Grassland, which is under the administration of the Pike and San Isabel National Forests. The RNA's specific location is within the SW 1/4 of Section 23, Township 34 South, Range 46 West, 6th Principal Meridian. It is located at 102 34'52" North latitude and 37 3'52" West longitude. Access to the RNA is available from either the U.S. highway or the maintained county roads that enclose it on its south and west sides (fig. 1).

Overview

This 14-hectare triangle of land lying between a sweeping curve of a U.S. highway and the Atchison, Topeka, and Santa Fe rail line is the result of a 10-year search for a pristine example of the shortgrass plains grama-buffalo grass community (including the grasses blue gramma (*Bouteloua gracilis*), side-oats gramms (*Bouteloua curtipendula*), and buffalo grass (*Buchloe dactyloides*)). The RNA has never been part of a grazing allotment, but the site was once used as a holding pen for livestock. It has not been plowed or subjected to other major disturbances (fig. 2).

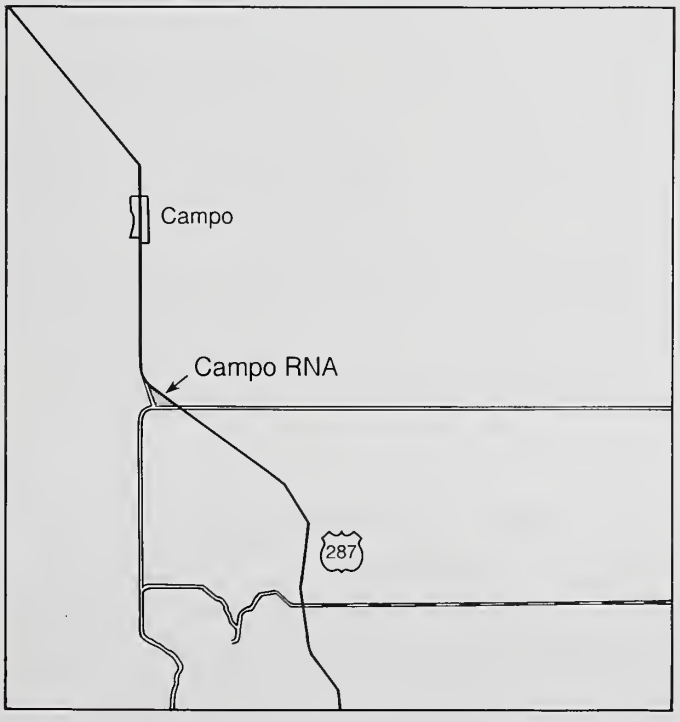

Figure 1. — Location of Campo RNA.

Figure 2. — Permanent vegetation transect at Campo RNA.

Climate

The climate at the RNA is semi-arid, with precipitation commonly coming from high-intensity storms,

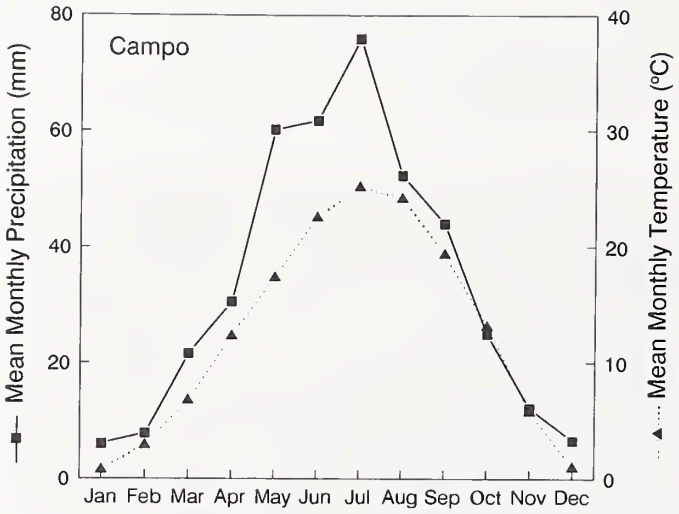

Figure 3. — Long-term average of monthly temperature and precipitation (from NOAA records) for the weather station closest to Campo RNA. Data were taken from the Campo 7S, CO, weather station, which is at an elevation of 1310 meters. The elevation of the RNA ranges from 1310-1315 meters, so actual climate at the RNA will likely be nearly the same as that shown. Precipitation was averaged over 38 years, and temperature was averaged over 18 years.

mostly during the growing season (fig. 3). The nearby weather station at the town of Campo reports an average annual precipitation of 404 millimeters and an average annual temperature of 13°C. Average annual monthly maximum temperature is 21°C; average annual monthly minimum temperature is 4°C. Depending on weather, grass growth will start about April 23 for cool-season species and May 7 for warm-season species. Hot windy periods result in a high evapotranspiration rate in the summer, which reduces the effectiveness of the moisture contribution to plant growth. Winters are commonly cold and windy with a moderate snowfall.

Physiography, Geology, and Soils

This RNA sits on open, windswept plains; its elevation varies from 1310 meters to 1315 meters. The site has no evident drainage, but it does slope slightly to the northwest on a loose-textured sandy loam soil. This soil has been derived from Eolian deposits, including dune sands, silt, and Peoria loess, which were laid down during the Pleistocene and Holocene periods. Dalhart, Mater, and Vona sandy loams are most common on the RNA site. A minute amount of Potter gravelly loam occurs at the highest elevation and, likewise, a small amount of Vona loamy soil on the lowest elevation at the north end of the site.

Flora

Plant cover in a relatively undisturbed state is the most striking characteristic feature of the RNA. Blue grama dominates the site, accounting for more than half of the vegetation composition in a transect reading in 1983; blue gramma is the climax dominant and continues to increase as the site proceeds toward climax. Buffalo-grass is next in the composition, followed by sideoats gramma. Grasses comprised more than 90% of the cover on the transect lines. The forb and shrub components are very low, as expected on a shortgrass plains site in late seral succession. The establishment record, on file at the Rocky Mountain Forest and Range Experiment Station, contains a partial list of common plants found on the RNA.

Fauna

Only two species have been officially reported: blacktailed jackrabbit (*Lepus californicus*) and western meadowlark (*Sturnella neglecta*). Other animals that would commonly be expected include pronghorn (*Antilocapra americana*), coyote (*Canis latrans*), eastern cottontail (*Sylvilagus floridanus*), desert cottontail (*S. audubonii*), prairie rattlesnake (*Crotalus viridis viridis*), and plains pocket gopher (*Geomys bursarius*). Other common birds expected are scaled quail (Callipepla squamata), mourning dove (*Zenaida macroura*), horned lark (*Eremophila alpestris*), and lark bunting (*Calamospiza melanocorys*).

In addition, an occasional lesser prairie chicken (*Tympanuchus pallidicinctus*), a Colorado State threatened species, may use the site. However, vehicle traffic continually passes the site on the highway, so disturbance is very high for this bird.

Status and Administration

Campo Research Natural Area was designated in July 1987. The site is managed under special management prescription 10A of the Pike and San Isabel National Forest Plan. The Carrizo and Timpas Units of the Comanche National Grassland (Springfield, CO 81073, 719-523-6591) have responsibility for administration and protection of the RNA.

For Information on conducting research on the RNA, contact:

Research Natural Area Coordinator
Rocky Mountain and Range
Experiment Station
240 West Prospect Road
Fort Collins, CO 80526-2098
(303) 498-1100

Research and Publications

Campo RNA may be used as a baseline site against which to compare manipulative activities on Shortgrass Plains sites. No studies on Campo have been published.

ESCALANTE CREEK RESEARCH NATURAL AREA

Location

Escalante Creek RNA is located approximately 25 miles southwest of Delta, Colorado, in Montrose and Mesa Counties. It is included within the boundaries of the Ouray Ranger District of the Uncompahgre National Forest, which is administered as a component of the Grand Mesa, Uncompahgre, and Gunnison National Forests. The RNA is located in portions of sections 14 and 23, Township 49 North, Range 14 West, New Mexico Prime Meridian. Latitude is 38 30' North, and longitude is 108 24' West.

Access to the area is from Delta via the Delta-Nucla Road, which is designated Forest Road 503 after it enters the national forest, and Forest Road 504, Cottonwood Road, which originates about 1/8 mile east of 25 Mesa Guard Station Road (fig. 1). The upper end of the RNA is located about 0.2 miles downstream from Forest Road 504. Access is also available from Forest Road 501, Cabin Bench Road, where it crosses the creek about 1.5 miles to the northeast. No roads or trails enter the area.

Figure 1. — Map of Escalante Creek RNA and vicinity.

Overview

The 18 hectares of Escalante RNA encompass the riparian zone of approximately 1.5 miles of the Dry Fork of Escalante Creek. The RNA is primarily characterized as an undisturbed stand of blue spruce (*Picea pungens*), with various age and size classes present (fig. 2).

Climate

There are no long-term weather records for the Uncompahgre Plateau. The nearest weather station is at Delta, Colorado, at elevation 1510 meters, and weather there has little resemblance to that occurring at the RNA. The climate of this portion of the plateau is characterized by long, cold winters and cool, dry summers. Forest Service hydrologic personnel have made some estimates of mean annual precipitation based on statistical analysis of 1970–1980 records of weather service stations surrounding the plateau, in conjunction with short-term storage gauge records from 1972–1980 on the plateau. This analysis, adjusted for elevation, shows that the RNA receives an estimated 584 millimeters of precipitation annually, 50–60% of which falls as snow.

Physiology, Geology, and Soils

Escalante Canyon is one of several deeply dissected canyons that break off the Uncompahgre Plateau and feed the rivers to the northeast, creating a series of nearly isolated mesas. Escalante Creek RNA is a riparian area wedged within the steep canyon walls of Escalante Creek, which flows northeasterly into the Gunnison River. Elevations within the RNA range from 2440–2500 meters above sea level. The soil is a sandy loam derived from a mixture of Dakota Sandstone alluvium, the Brushy Shale member of the Morrison Formation and the Entrada Sandstone.

Flora

The plant association in the blue spruce forest on the RNA is different from published plant associations for blue spruce and, therefore, it is likely a new

Figure 2. — Escalante RNA.

plant association. About 50% of the trees found on the RNA are blue spruce, and the stand is uneven-aged with mature trees of about 120 years old. The blue spruce is restricted to the creek bottom and rapidly disappears above the riparian zone. Other tree species occurring with the blue spruce are Engelmann spruce (*Picea engelmannii*), Douglas-fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), and aspen (*Populus tremuloides*).

Common shrubs and herbaceous plants include shrubby cinquefoil (*Potentilla fruticosa*), mountain snowberry (*Symphoricarpos oreophilus*), thinleaf alder (*Alnus tenuifolia*), willow (*Salix spp.*), serviceberry (*Amelanchier alnifolia*), common juniper (*Juniperus communis*), yarrow (*Achillea millefolium* ssp. *lanulosa*), paintbrush (*Castilleja* spp.), aster (*Aster* spp.), oxeye daisy (*Chrysanthemum* spp.), meadow rue (*Thalictrum* spp.), marsh marigold (*Caltha leptosepala*), sedge (*Carex* spp.), and tufted hairgrass (*Deschampsia caespitosa*). A more complete list of flora found on the RNA is included in the establishment record, on file at the Rocky Mountain Forest and Range Experiment Station in Fort Collins, Colorado.

Fauna

The area is used as summer range by elk (*Cervus elaphus*) and mule deer (*Odocoileus hemionus*) and as year-round habitat for small animals and migratory birds. Red squirrels (*Tamiasciurus hudsonicus*) are common, and there are old signs of use by beaver (*Castor canadensis*). Other nongame and small-game animals frequent the area. A partial list of birds includes mountain chickadee (*Parus gambeli*), turkey vulture (*Cathartes aura*), dark-eyed junco (*Junco hyemalis*), Clark's nutcracker (*Nucifraga columbiana*), and red-

breasted nuthatch (*Sitta canadensis*). No known endangered or threatened plant or animal species occur on the site.

Status and Administration

Escalante Creek RNA was designated in February 1985, the 150th Research Natural Area to be established within the Forest Service network. It is administered under special management prescription 10A of the Grand Mesa, Uncompahgre and Gunnison National Forest Plan. The Ouray Ranger District (Montrose, CO 81402, 303-249-3711) has responsibility for administration and protection of the RNA.

For information on conducting research on the RNA, contact:

Research Natural Area Coordinator
Rocky Mountain Forest and Range
Experiment Station
240 West Prospecte Road
Fort Collins, CO 80526-2098
(303) 498-1100

Research and Publications

Escalante Canyon RNA is an appropriate site for research on the succession of blue spruce forests and represents the montane riparian zone. We found no published studies on Escalante Canyon.

GOTHIC RESEARCH NATURAL AREA

Location

Gothic RNA is located 8 miles north-northwest of Crested Butte, Gunnison County, Colorado. The area is contained in portions of sections 19, 20, 21, 28, 29, and 30 of Township 12 South, Range 86 West, 6th Principal Meridian. It is managed as part of the Taylor River Ranger District, Grand Mesa, Uncompahgre, and Gunnison National Forests.

To reach the RNA from the town of Crested Butte, take the road to Mount Crested Butte and Gothic (Forest Road 317); the RNA is approximately 2 miles to the northwest of the town of Gothic and the Rocky Mountain Biological Laboratory. At its closest point, the RNA lies only about 0.75 miles from Forest Road 317 along Trail #403 (fig. 1).

Overview

The 425-hectare Gothic RNA is an outstanding example of the Engelmann spruce-subalpine fir (*Picea engelmannii-Abies lasiocarpa*) community that is typical of the subalpine forests of the western slope of Colorado. Lying at elevations from approximately 3020–3905 meters above sea level on the north/northeast-facing slopes of Mount Baldy, the area contains a variety of habitats and animal species typical of this community, as well as diverse geological features that include glacial cirques, moraines, talus slopes, and high alpine lakes (fig. 2).

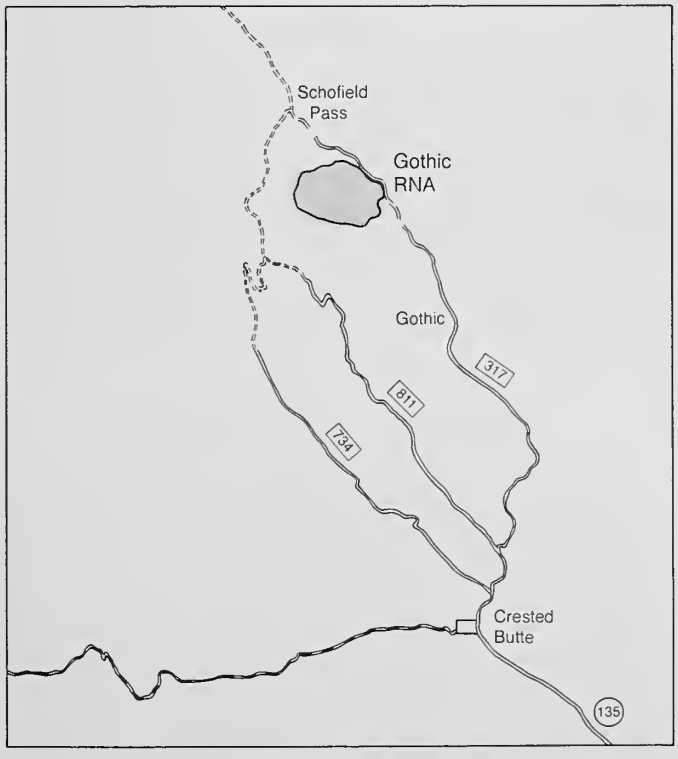

Figure 1. — Map of Gothic RNA and vicinity.

Figure 2. — Gothic RNA (photograph by Barry C. Johnston).

Climate

No climatic data is available directly from the Gothic RNA. However, data from the town of Crested

Butte (elevation 2700 meters) show an average annual precipitation of 591 millimeters and an average annual temperature of 2°C (fig. 3). The average annual monthly maximum temperature is 11°C. Average annual monthly minimum temperature is –8°C. Killing frosts can occur at any time of the year.

Physiography, Geology, and Soils

The area consists of the drainage of Quigley Creek, with portions of other small tributaries draining into the East River. Slopes are east-facing, and elevations range from 3020 meters above sea level at the East River on the RNA's eastern edge to nearly 3905 meters at the summit of Mount Baldy. Gothic RNA is underlain by Pierre shale, Tertiary porphyry, and glacial till and outwash. Many small lenses of limestone and calcacerous shales are present; most of these are less than a foot thick, but a few are 0.5–1 meter thick. Although most of the area's dikes and sills are obscured by thick forest vegetation, at least three closely spaced sills are well exposed; these sills crop out along the south side of Quigley Creek, forming a wall-like cliff. Three-fourths of the way up Quigley Creek, the sills cross the creek, creating a series of prominent cascades. Upstream from the cascades, the valley becomes a hanging cirque with steep south and west walls cut in Pierre shale. The soils of the RNA are derived chiefly from the Pierre shale and are black in color. In some of the upper regions, the shale is only partially disintegrated, and some alpine plants are growing on this material.

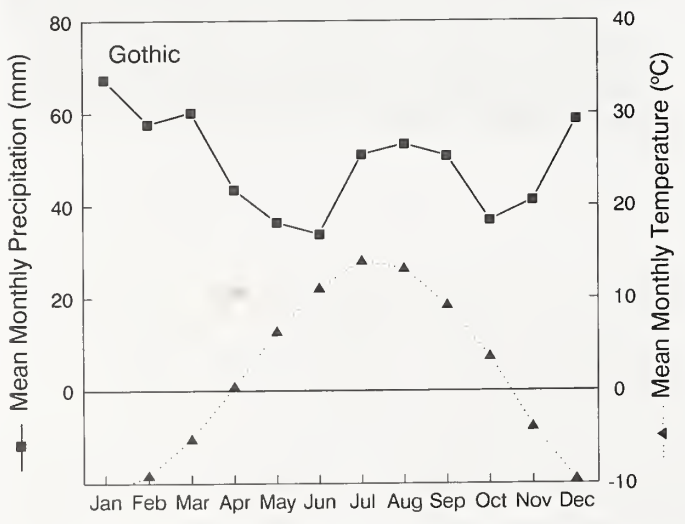

Figure 3. — Long-term average of mean monthly temperature and precipitation (from NOAA records) for the weather station closest to Gothic RNA. Data were taken from the Crested Butte, CO, weather station, which is at an elevation of 2700 meters. The elevation of the RNA ranges from 3020–3905 meters, so actual climate at the RNA will likely be quite different from that shown. Precipitation was averaged over 83 years, and temperature was averaged over 82 years.

Flora

The majority of the area within Gothic RNA is classified as forests dominated by Engelmann spruce and subalpine fir. Dominant cover types are: wet meadow (96 ha), mature spruce-fir (150 ha), young spruce-fir (42 ha), treeline spruce-fir (23 ha), and barren or rock (114 ha).

Common plants in the spruce-fir forests include myrtle blueberry (*Vaccinium myrtillus*), bush honeysuckle (*Lonicera involucrata*), currant (*Ribes* spp.), red-berried elder (*Sambucus racemosa*), heartleaf arnica (*Arnica cordifolia*), clasped-leaf twisted-stalk (*Streptopus amplexifolius*), curled lousewort (*Pedicularis racemosa*), and avalanche lily (*Erythronium grandiflorum*). Common plants in the meadow include fringed brome (*Bromus ciliatus*), white-flowered peavine (*Lathyrus leucanthus*), slender cinquefoil (*Potentilla gracilis*), southern ligusticum (*Ligusticum porteri*), red-berried elder (*Sambucus racemosa*), and currant.

Fauna

The fauna consists of mule deer (*Odocoileus hemionus*), elk (*Cervus elaphus*), black bear (*Ursus americanus*) and coyote (*Canis latrans*) that may inhabit the area for short periods during the summer months. In addition, numerous fur-bearers, including marten (Martes americanus), muskrat (*Ondatra zibethicus*), weasels (*Mustella* spp.), and miscellaneous rodents, can be found year-round. Two small lakes support brook trout (*Salvelinus fontinalis*).

Status and Administration

Gothic was designated a Research Natural Area in July 1931 and had its boundaries revised in 1959. The site was registered as a scientific natural area by the Colorado Natural Areas Program in September 1978. The RNA is managed under special management prescription 10A of the Grand Mesa, Uncompahgre, and Gunnison National Forest Plan. The Taylor River Ranger District (Gunnison, CO 81230, 303-641-0471) has responsibility for administration and protection of the RNA.

For information on conducting research on the RNA, contact:

Research Natural Area Coordinator
Rocky Mountain Forest and Range
Experiment Station
240 West Prospect Road
Fort Collins, CO 80526-2098
(303) 498-1100

Research

The area's natural qualities, and its proximity to the Rocky Mountain Biological Laboratory in Gothic, make it well adapted for biological research and teaching purposes. Much field research is conducted at the lab, and the lab has cooperative agreements for research on areas adjacent to the RNA. However, the lab has not conducted research on the RNA itself.

Publications

McCullough, H.A. 1952. The Gothic Natural Area. The Living Wilderness. 41: 13–20.

McCullough, H.A. 1956. Survey of the Gothic Natural Area. The Scientific Monthly. 82: 25–32.

HURRICANE CANYON RESEARCH NATURAL AREA

Location

The RNA is located 3 miles northwest of Manitou Springs, Colorado, in El Paso County, Pikes Peak Ranger District, Pike and San Isabel National Forests. The area includes portions of sections 34 and 35, Township 13 South, Range 68 West, 6th Principal Meridian.

The RNA lies 3–4 miles above the Manitou Incline (Cog Railway). The easiest access is via Trail #703, the Barr Trail-French Creek Trail. The trailhead is at the Cog Railway Station on U.S. 24 in Manitou Springs (fig. 1).

Overview

Because of its rugged terrain and inaccessibility, the 211-hectare Hurricane Canyon RNA (fig. 2) is a remnant example of the original east-slope montane forests—most of which have long since been logged or grazed. The dominant overstory tree is Douglas-fir (*Pseudotsuga menziesii*), but ponderosa pine (*Pinus ponderosa*) is also abundant. Oakbrush transition communities occur in the northern portion of the RNA and Engelmann spruce (*Picea engelmannii*) and Colorado blue spruce (*Picea pungens*) occur along the stream banks.

Climate

Winters at the RNA are dry, and the minimal snow accumulations are restricted to northern slopes. Climate data from Ruxton Park, the weather station nearest the RNA, shows that average annual precipitation is 596 millimeters and average annual temperature is 3°C (fig. 3). The average annual monthly maximum temperature is 10°C; the average annual monthly minimum temperature is –5°C. Typically, 40–50% of the site's annual precipitation falls in June, July, and August.

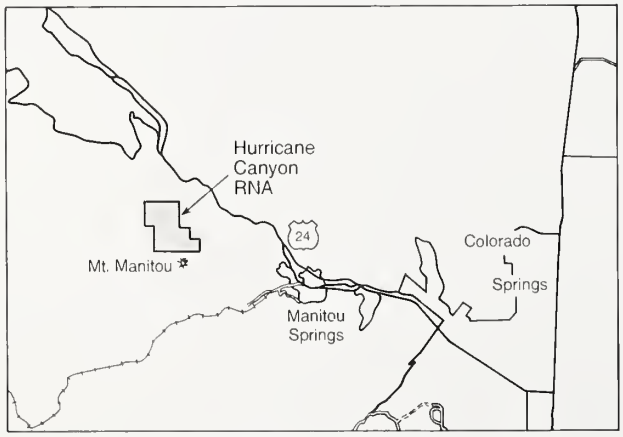

Figure 1. — Location of Hurricane Canyon RNA.

Figure 2. — Hurricane Canyon RNA (photograph by Barry C. Johnston).

Physiography, Geology, and Soils

The terrain consists of two primary and several secondary canyons. Their steep sides were cut by the north and south forks of French Creek, a tributary of

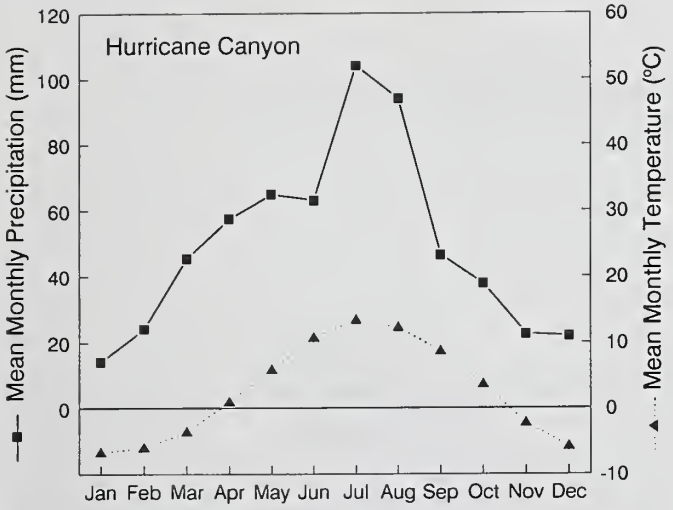

Figure 3. — Long-term average of mean monthly temperature and precipitation (from NOAA records) for the weather station closest to Hurricane Canyon RNA. Data were taken from the Ruxton Park, CO, weather station, which is at an elevation of 2760 meters. The elevation of the RNA ranges from 2255–2805 meters, so actual climate at the RNA will likely be quite different than that shown. Precipitation and temperature were averaged over 33 years.

Fountain Creek. Rock outcrops are abundant on the ridges and, in places, the canyons are boulder-filled. Elevations range from 2255–2805 meters above sea level. The area's geology is typical of much of the east slope of the Front Range, and the parent rock is weathered Pikes Peak granite. Soils are generally gravelly, with narrow bands of colluvial soil found along the stream bottoms.

Flora and Fauna

Information about forbs, grasses, and shrubs has not been collected on the RNA. The area receives limited use as a wintering ground by elk (*Cervus elaphus*). Detailed surveys of fauna have not been done for the RNA.

Status and Administration

Hurricane Canyon was designated a natural area in 1931. An establishment record was completed in 1966. It is managed under special management prescription 10A of the Pike and San Isabel National Forest Plan. Hurricane Canyon was designated a Scientific Natural Area under the Colorado Natural Areas Program in October 1980.

For information on conducting research on the RNA, contact:

Research Natural Area Coordinator
Rocky Mountain Forest and Range
Experiment Station
240 West Prospect Road
Fort Collins, CO 80526-2098
(303) 498-1100

Research and Publications

The RNA represents undisturbed examples of ecosystems that have been severely disturbed elsewhere in the Front Range of Colorado. Also, the RNA contains distinct watersheds with both riparian and upslope vegetation. The Engelmann spruce and blue spruce stands along the streamsides could be studied for hybridization between the two species. We found no published studies from the RNA.

LIMBER PINE RESEARCH NATURAL AREA

Location

Limber Pine Research Natural Area is located in Slope County, southwestern North Dakota, 95 miles southwest of Dickinson, North Dakota, in the Medora Ranger District of the Little Missouri National Grasslands, Custer National Forest. The approximate center of the RNA is at latitude 46 27'55" North and longitude 103 54'58" West. The RNA is contained in sections 30 and 31, Township 135 North, Range 105 West, 5th Principal Meridian.

Under dry or frozen conditions, the RNA can be reached by automobile from either the north or the south. From Marmath, North Dakota, proceed 1.5 miles west on State Highway 12 to Forest Road 783 (the West River Road); go north about 12 miles. Turn east on an undeveloped trail (Forest Road 782) and proceed about 4 miles east to the southwestern corner of the the limber pine stand (which is on private land) in Section 36. The route continues east, skirting around the RNA, and connects with the access route from the north.

Alternately, from Golva, North Dakota, which is 14 miles from the Beach Exit on Interstate 94, go 7 miles south, 1 mile west, and 6 miles south on State Highway 16 to a four-way junction. Turn left (east) on the county road and go 2 miles trending east and south, past the Horse Creek Grazing Association Headquarters. Continue about 6 miles to the Brown Ranch. In the extreme northwest 1/4 of Section 28, less than 1/4 mile from the ranch headquarters and immediately northwest of a clay knob, is an unmarked turn-off to an undeveloped private trail that fords Cannonball Creek and enters the RNA's extreme northeastern corner. Figure 1 shows the access routes to the RNA.

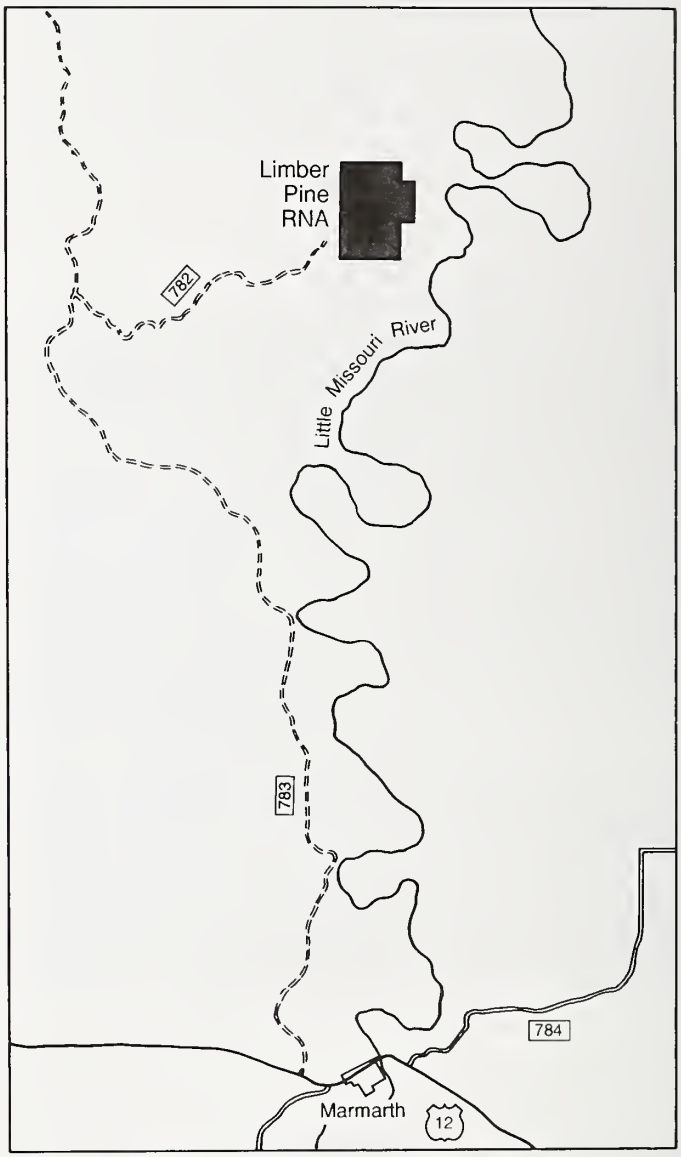

Figure 1. — Location of Limber Pine RNA.

Overview

This 276-hectare RNA protects a disjunct stand of limber pine (*Pinus flexilis*) at the northeasternmost extent of its range. The stand is in a relatively undisturbed setting among grassland types common to the Little Missouri River Badlands (fig. 2). The RNA harbors at least six state rare animal and plant species. Twenty-three prehistoric sites have been documented adjacent to the RNA. This density and distribution of prehistoric sites in the general limber pine area are considered atypical compared to similar stream valleys and ridge complexes elsewhere in the Little Missouri National Grasslands.

Climate

The climate of southwestern North Dakota is characterized by extreme temperature differences within

Figure 2. — Limber Pine RNA (photograph by Angela Evenden).

and between seasons, light to moderate precipitation that tends to peak in spring, low relative humidity, plentiful sunshine, nearly continuous air movement, and high overall variability in precipitation and temperature between years. Mild, dry west winds prevail during the growing season, which is about 120 days near the RNA. Cold and dry air masses from the north prevail during the winter. Warm air masses from the south are the most frequent source of rain, which accounts for the majority of precipitation.

Climate data for Bowman Courthouse, North Dakota, the weather station nearest the RNA, shows an average annual precipitation of 385 millimeters and an average annual temperature of 6°C (fig. 3). Average annual monthly maximum temperature is 13°C, and average annual monthly minimum temperature is –1°C.

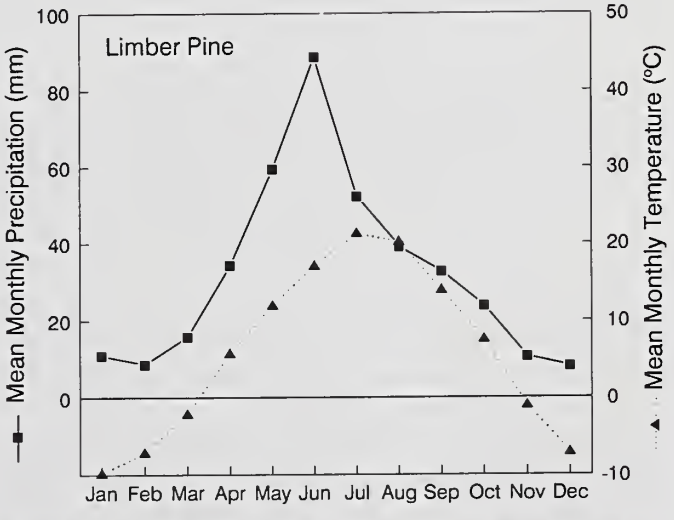

Figure 3. — Long-term average of mean monthly temperature and precipitation (from NOAA records) for the weather station closest to Limber Pine RNA. Data were taken from the Bowman Courthouse, ND, weather station, which is at an elevation of 910 meters. The elevation of the RNA ranges from 800–895 meters, so actual climate at the RNA will likely be nearly the same as that shown. Precipitation was averaged over 76 years, and temperature was averaged over 74 years.

Physiography, Geology, and Soils

Limber Pine RNA lies in the southwestern unglaciated corner of North Dakota, in the physi-

ographic region referred to as the Missouri Slope. Elevations at the RNA range from 895 meters at the ridgetops to 800 meters at the northeastern corner above Cannonball Creek. The RNA is made up of highly dissected Badlands terrain, composed mainly of sedimentary Ludlow Formation bedrock. The area is considered to be one of the best exposures of this formation.

Over half of the exposed stratigraphic column in the RNA is composed of "Limber Pine Sandstone." It is discontinuous across the area and is relatively more susceptible to erosion. Above this, the uppermost 14 meters has a striped bedding of finegrained winnowed sandstone separated by bands of ash, lignite, shale, and clinker, which interfinger with massive clay overlying alternations of clay and coarse clastics. (Clinker is a clay layer commonly referred to as "scoria," which forms the resistant caprock across the highest elevations.)

All of the RNA is within the general Badlands land type. Its main soil types are Brandenburg-Cabba complex, which dominates the highly dissected upland terrain; Patent loam, which is found in relatively small areas lower on the catena on 6–15% slopes and is derived from colluvial material on fans and foot slopes; and Badlands-Cabbart complex (9–15% slopes), which constitutes the lowland soils and erodible upland slopes. This last is not a soil series, but a term referring to eroding outcrops of soft shale with limited or no soil development and sparse vegetation.

Flora

The most recent published study (Beckes et al. 1982) shows evidence that prehistoric man played a primary role in the origin of the limber pine stand at the RNA. Their conclusion was based on the fact that the stand was young and that it apparently had a single point of origin.

About 12 hectares of the RNA are the limber pine cover type; 18 hectares are the Rocky Mountain juniper (*Juniperus scopulorum*) cover type; and the remaining 245 hectares are nonforest types. The dominant nonforest types are saltbrush-greasewood (*Atriplex sarcobatus*): 40 hectares; sagebrush steppe (*Agropyron spicatum-Artemisia tridentata*): 61 hectares; and wheatgrass-needlegrass (*Agropyron-Stipa*): 142 hectares.

Five rare or otherwise interesting plants have been observed or collected within the RNA:

Kinnikinnick (*Arctostaphylos uva-ursi*)—a disjunct occurrence of a boreal species.

Little barley (*Hordeum pusillum*)—state rare plant; grows on clay outwash.

Dwarf mentzelia (*Mentzelia pumila*)—represents the only recent record of this state endangered plant in North Dakota. Grows in the open on scoria and on underlying ash residue.

Limber pine—represents the only record of this state endangered plant in North Dakota.

Wax currant (*Ribes cereum*)—state sensitive rare plant. Grows on scoria ridgetops and sandstone in a range of open to shaded conditions.

Flora of the Limber Pine RNA have not been thoroughly collected, described, or analyzed. A list of plants known to occur on the RNA is included in the establishment record, which is on file at the Rocky Mountain Forest and Range Experiment Station in Fort Collins, Colorado.

Fauna

Vertebrate species have not been inventoried or systematically studied in the RNA, but they have been inventoried regionally in southwestern North Dakota. Reptiles known to occur in the area include prairie rattlesnake (*Crotalus viridis viridis*), short-horned lizard (*Phrynosoma douglassii*), and sagebrush lizard (*Sceloporus graciosus*)—a state rare species. Species of birds reported in the area include golden eagle (*Aquila chrysaetos*), ferruginous hawk (*Buteo regalis*), turkey vulture (*Cathartes aura*), sage grouse (*Centrocercus urophasianus*), merlin (*Falco columbarius*), Clark's nutcracker (*Nucifraga columbiana*), common poorwill (*Phalaenoptilus nuttallii*), and Brewer's sparrow (*Spizella breweri*).

Mammals in the area include pronghorn (*Antilocapra americana*), coyote (*Canis latrans*), porcupine (*Erethizon dorsatum*), desert and eastern cottontails (*Sylvilagus audubonii* and *S. floridanus*), and the state rare Ord's kangaroo rat (*Dipodomys ordii*). Mule deer (*Odocoileus hemionus*) use the area heavily throughout the year; pronghorn use is heaviest in the winter. Bobcat (*Felis rufus*) were trapped here in the 1960s, but have not returned. The only state rare animals whose breeding habitat is confirmed as entering the RNA are the golden eagle and the poorwill.

A more complete list of vertebrates found in the immediate area of the RNA is contained in the establishment report, which is on file and the Rocky Mountain Forest and Range Experiment Station in Fort Collins, Colorado.

Status and Administration

Limber Pine was established as an RNA in July 1991. It is administered under special management prescription 10A of the Custer National Forest Management Plan. The Medora Ranger District of the Little Missouri National Grassland (Dickinson, ND 58601, 701-225-5151) is responsible for administration and protection of the RNA.

For information on conducting research on the RNA, contact:

Research Natural Area Coordinator
Rocky Mountain Forest and Range
Experiment Station
240 West Prospect Road
Fort Collins, CO 80526-2098
(303) 498-1100

Research

The RNA continues to draw researchers interested in its disjunct limber pine stand. The RNA is also suited for research into any of its rare plant communities or plant species, as well as general research involving the Little Missouri Badlands area.

Publications

Beckes, M.R.; Jagler, B.K.; Burge, T.L.; and Love, T.G. 1982. Possible cultural origin of an isolated stand of Pinus flexilis in the Little Missouri Badlands. Journal of the North Dakota Archeological Association. 1: 9–20.

Love, T.L. 1982. Limber pine in North Dakota. North Dakota Outdoors. 42: 8–9.

Potter, L.D; and Green, D.L. 1964. Ecology of a northeastern outlying stand of Pinus flexilis. Ecology. 45: 866–68.

Williams, R.P. 1988. Limber pines. North Dakota Outdoors-Natural Areas Guide. 50: 16.

MOUNT GOLIATH RESEARCH NATURAL AREA

Location

The Mount Goliath Research Natural Area lies 8 miles southwest of Idaho Springs, in Clear Creek County, in the Clear Creek Ranger District of the Arapaho and Roosevelt National Forests. The RNA occupies portions of sections 5, 6, 7, and 8 of Township 5 South, Range 73 West, 6th Principal Meridian. The north edge of the site adjoins a parking lot off Colorado State Highway 5 (the "Mount Evans Highway"), approximately 3 miles above Echo Lake and the junction of State Highway 105 with State Highway 5 (fig. 1). From the parking lot, the M. Walter Pesman Alpine Trail, maintained in cooperation with the Denver Botanic Gardens, cuts through the site and eventually rejoins the highway above the RNA.

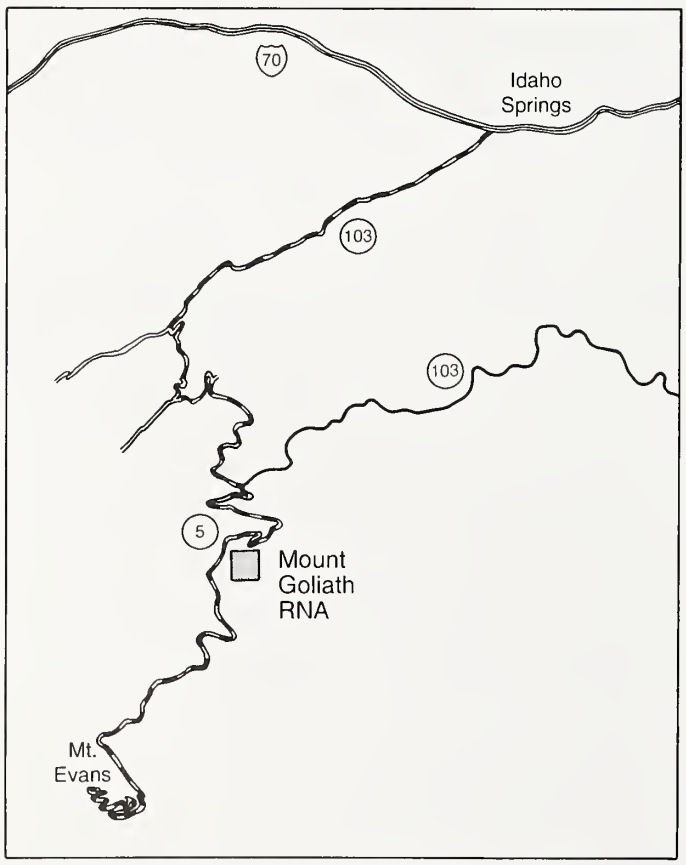

Figure 1. — Map of Mount Goliath RNA and vicinity.

Overview

The 65-hectare Mount Goliath RNA was created in 1950 to preserve a significant population of bristlecone pine (*Pinus aristata*), located near the northern limits of its range. At timberline, the bristlecone have become gnarled and twisted by the wind into peculiar and distorted shapes, reflecting the severity of the climate (fig. 2). The bristlecone pine in this stand include one of the oldest known *Pinus aristata* in Colorado—more than 1,500 years old. The original size of the RNA, 130 hectares, was reduced to 65 hectares in 1957 to eliminate acreage crossed by the Mount Evans Highway and acres being used for recreation.

Climate

Based on NOAA data taken at the Mount Evans Experiment Station, which is at a roughly comparable elevation to Mount Goliath, average annual precipitation is 962 millimeters, and the average annual temperature is –2°C (fig. 3). The average annual monthly maximum temperature is 4°C, and the average monthly minimum temperature is –7°C.

Physiography, Geology, and Soils

The RNA is located just below the summit of Mount Goliath on the mountain's north and east slopes. The RNA lies on the headwaters of Vance Creek, a tributary of the South Platte River via Bear Creek. Slopes are generally moderate, and elevations range from 3445–3690 meters above sea level. The area is composed of igneous granite and metamorphic schist.

Flora

Most of the area is dominated by bristlecone pine, with scattered Engelmann spruce (*Picea engelmannii*). The lower, eastern side of the RNA (about 49 hectares) consists of bristlecone pine and whiproot clover (*Trifolium dasyphyllum*) with Engelmann spruce interspersed. The remaining higher, western part of the RNA (about 16 hectares) is alpine kobresia (*Kobresia myosuroides*) with a few bristlecone pine in-

Figure 2. — Bristlecone pine in Mount Goliath RNA.

terspersed. One study (Hartman and Mitchell 1979) documented 94 plant species in 24 different families in the RNA. Except for the trail across the RNA and trampling around the parking lot, the plant communities within the RNA receive little disturbance. Visibility from the highway has probably impeded vandalism of the bristlecone pines, but an interpretive sign at the parking lot has to be replaced every few years.

The most common plants found in the bristlecone pine forests on the RNA include yarrow (*Achillea millefolium* ssp. *lanulosa*), field wormwood (*Artemisia campestris*), tufted hairgrass (*Deschampsia caespitosa*), hairy golden aster (*Heterotheca villosa*), beard-tongue (*Penstemon* sp.), common stonecrop (*Sedum stenopetalum*), whiproot clover (*Trifolium dasyphyllum*), and spike trisetum (*Trisetum spicatum*).

The most common plants in the alpine areas on the RNA include alpine sandwort (*Minuartia obtusiloba*), dwarf sagewort (*Artemisia scopulorum*), kobresia sedge (*Carex elynoides*), tufted hairgrass

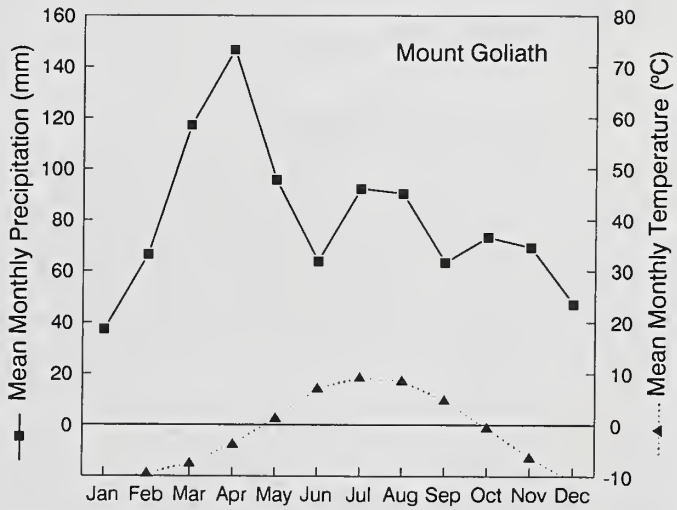

Figure 3. — Long-term average of mean monthly temperature and precipitation (from NOAA records) for the weather station closest to Mount Goliath RNA. Data were taken from the Mount Evans Experiment Station, CO, weather station, which is at an elevation of 3240 meters. The elevation of the RNA ranges from 3445–3690 meters, so actual climate at the RNA will likely be similar to that shown. Precipitation and temperature were averaged over 9 years.

(*Deschampsia caespitosa*), sheep fescue (*Festuca brachyphylla*), golden avens (*Acomastylis rossii*), nailwort (*Paronychia pulvinata*), sky pilot (Polemonium viscosum), whiproot clover (*Trifolium dasyphyllum*), and Parry clover (*Trifolium parryi*).

Fauna

The RNA is occasionally used by bighorn sheep (*Ovis canadensis*) and elk (*Cervus elaphus*).

Status and Administration

Mount Goliath was designated a Research Natural Area in May 1950. It was designated a natural area by the Colorado Natural Areas Program in October 1980. The RNA is managed under special management prescription 10A of the Arapaho and Roosevelt National Forest Plan. The Clear Creek Ranger District (Idaho Springs, CO 80452, 303–576–2901) has responsibility for administration and protection of the RNA.

For information on conducting research on the RNA, contact:

Research Natural Area Coordinator
Rocky Mountain Forest and Range
Experiment Station
240 West Prospect Road
Fort Collins, CO 80526-2098
(303) 498-1100

Research

The Denver Botanic Gardens (909 York Street, Denver, CO 80206; 303-331-4000) maintains a plant collection of species found on the RNA and has been interested in the flora of the RNA for years. The RNA represents the ecotone between subalpine forest and tundra and could be monitored for changes caused by changes in climate. Dr. Anna Shoettle (Rocky Mountain Forest and Range Experiment Station) studied needle retention in bristlecone pine as an indicator of stress in 1992.

Publications

Ash, S. 1968. Mount Goliath: past, present and future. The Green Thumb. 25: 79–80. (Publication of Denver Botanic Gardens.)

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Brunquist, E.H. 1963. Mt. Goliath relatives of garden plants: common plants of the M. Walter Pesman Alpine Trail. Denver, CO: Denver Botanic Gardens. 7 p.

Brunquist, E.H. 1963. The alpine-subalpine trails of Mount Goliath. The Green Thumb. 20: 166–168.

Graham, J. 1986. A day with Goliath. Colorado Outdoors. 35: 16–17.

Hartman, J. 1978. Plant study on Mount Goliath. The Green Thumb. 35: 55–61.

Hartman, J.; Mitchell, R. 1979. Plants of Mount Goliath Research Natural Area. Prairie Naturalist. 11: 39–48.

Krebs, P. 1965. Dendrochronology and the distribution of bristlecone pine (Pinus aristata) in Colorado. Boulder, CO: University of Colorado. Ph.D. dissertation.

Roth, H. 1955. Something new in old trees. Natural History. June.

Schoettle, A.W. 1993. Comparison of shoot, needle, and physiological characteristics of erect and dwarf Bristlecone pine (Pinus aristida) trees at treeline. Bulletin of the Ecological Society of America. 74: 429.

Shanklin, J.F. 1960. Society of American Foresters natural areas. Journal of Forestry. 58: 483–484.

Wingate, J.L. 1982. Alpine Wildflowers of Mt. Goliath. Denver: Denver Botanic Gardens. Pamphlet.

Zeiner, H.M. 1967. Checklist of flowers: the Mount Goliath Alpine Unit. The Green Thumb. 24: 103–106.

NARRAGUINNEP RESEARCH NATURAL AREA

Location

Narraguinnep RNA lies 17 miles northwest of Dolores, Colorado, in the Dolores Ranger District of the San Juan National Forest, at latitude 37 42' North and longitude 108 40' West. The RNA is located in portions of sections 19, 20, 29, 30, and 31, Township 40 North, Range 16 West, New Mexico Principal Meridian; and portions of sections 1 and 2, Township 39 North, Range 17 West, New Mexico Principal Meridian.

Topographic barriers and lack of trails render this RNA relatively inaccessible. To reach the RNA, take Colorado State Highway 666 approximately 9 miles southeast from Dove Creek to Cahone. Turn east on a dirt road and go 3 miles, then turn south for approximately 1.3 miles. Turn east on County Road 505, cross Bradfield Bridge and turn onto Forest Service Road 504. Narraguinnep Canyon parallels Forest Service Road 504, which lies about 0.5 miles to the northwest of the canyon. The RNA can be reached by traveling cross-country from this road (fig. 1).

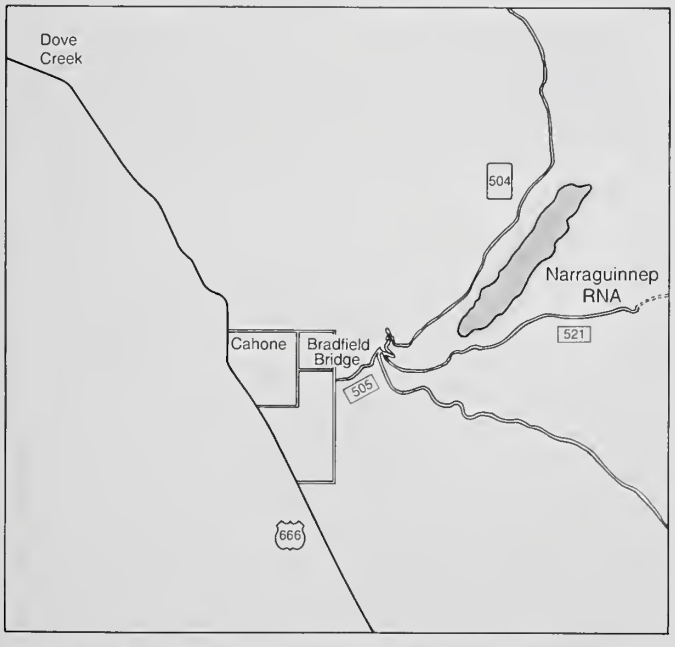

Figure 1. — Map of Narraguinnep RNA and vicinity.

Overview

Narraguinnep RNA is a 781-hectare site in Narraguinnep Canyon that contains an outstanding example of undisturbed native plant and animal communities, typical of the canyon mesa country of southwestern Colorado (fig. 2). The area is dominated by stands of ponderosa pine (*Pinus ponderosa*) and mixed pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) woodlands, as well as dense stands of scrub oak (*Quercus gambellii*). Moderately steep slopes with rimrock and steep rock cliffs form the canyon.

Climate

The RNA's climate is typical of the canyonlands of southwestern Colorado. The average annual frostfree period runs from June 10 to September 15. Averages of 30 years of NOAA data taken at Yellow Jacket 2W (elevation 2090 meters) show an average annual precipitation of 397 millimeters and an average annual temperature of 8°C (fig. 3). The average annual monthly maximum temperature is 16°C; the average annual monthly minimum temperature is 1°C. Since elevations at the RNA range from 2040–2440 meters, actual climate at the site will likely be quite different from the Yellow Jacket data.

Physiography, Geology, and Soils

The canyon has fairly steep slopes and, in places, rimrock and steep rock cliffs. Elevations range from 2040 meters above sea level at the bottom of the canyon at the lower end of the area to 2440 meters at the highest point on the rim of the canyon. The exposed geological formations are topped by the Dakota sandstone formation, which is underlain by McElmo and LaPlata sandstone—all of sedimentary origin. The soil is the result of the disintegration of these formations. In general, the soil is not very deep on the canyon sides, but deep and fertile on the canyon floor.

Flora

Ponderosa pine and pinyon-juniper are the dominant trees within this RNA. Aspen (*Populus tremu-*

Figure 2. — Narraguinnep RNA.

loides) is found only in the bottom of the canyon; the dominant shrub is Gambel oak. A baseline ecological study of the RNA (Somers et al. 1980) identified six plant associations at the site: Gambel oak-mountain snowberry (*Symphoricarpos oreophilus*): 95 ha; Ponderosa pine-Gambel oak: 285 ha; Gambel oak-Utah serviceberry (*Amelanchier utahensis*): 190 ha; Rocky Mountain juniper (*Juniperus scopulorum*)-Gambel oak: 19 ha; Utah juniper-pinyon pine: 176 ha; Gambel oak-alderleaf mountain mahogany (*Cercocarpus montanus*): 16 ha.

The pinyon-juniper type has an open stand of pinyon and juniper with trees varying in size from seedlings to mature. The oakbrush type consists of a more

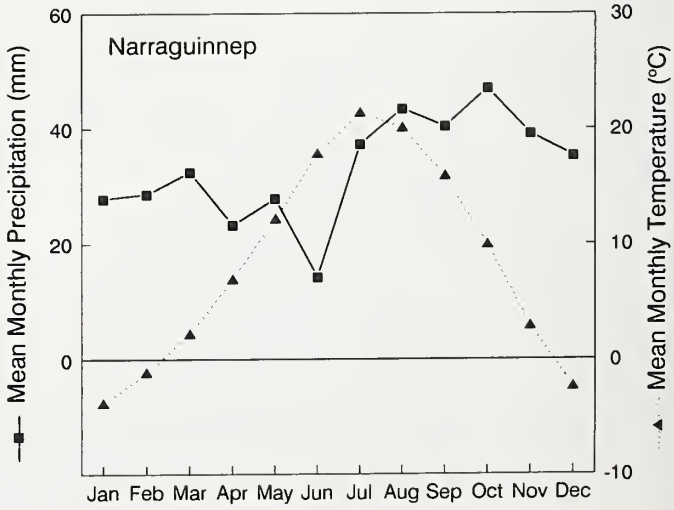

Figure 3. — Long-term average of mean monthly temperature and precipitation (from NOAA records) for the weather station closest to Narraguinep RNA. Data were taken from the Yellow Jacket 2W, CO, weather station, which is at an elevation of 2090 meters. The elevation of the RNA ranges from 2040–2440 meters, so actual climate at the RNA will likely be quite different from that shown. Precipitation and temperature were averaged over 30 years.

or less dense stand of scrub oak mixed with rose (*Rosa* spp.), ceanothus (*Ceanothus fendleri*), Utah serviceberry, chokecherry (*Prunus virginiana* var. *melanocarpa*), bitterbrush (*Purshia tridentata*) and mountain snowberry (*Symphoricarpos oreophilus*). The four most common species of herbaceous angiosperms were blue-eyed Mary (*Collinsia parviflora*), muttongrass (*Poa fendleriana*), whiteflowered peavine (*Lathyrus leucanthus*), and elk sedge (*Carex geyeri*). No cutting has been reported of any of these types, although the pinyon, juniper, and ponderosa pine were judged to be merchantable in 1962. Somers et al. (1980) contains an extensive list of plants found on the RNA.

Fauna

Somers et al. (1980) reported the presence of chorus frog (*Pseudacris triseriata*), short-horned lizard (*Phrynosoma douglassii*), eastern fence lizard (*Sceloporus undulatus*), and many-lined skink (*Eumeces multivirgatus*). They found 33 species of birds on the RNA and another 11 near the RNA. They also counted 11 species of small mammals, as well as coyote (*Canis latrans*), black bear (*Ursus americanus*), elk (*Cervus elaphus*), and mule deer (*Odocoileus hemionus*).

Status and Administration

Narraguinnep was designated as an RNA in July 1932 for 1,134 hectares; the area was reclassified and the acreage reduced to 781 hectares in May 1962. The RNA was designated a scientific natural area by the Colorado Natural Areas Program in October 1980. It is managed under special management prescription 10A of the San Juan National Forest Plan. The Dolores Ranger District (Dolores, CO 81323, 303-882-7296) has responsibility for administration and protection of the RNA.

For information on conducting research on the RNA, contact:

Research Natural Area Coordinator
Rocky Mountain Forest and Range
Experiment Station
240 West Prospect Road
Fort Collins, CO 80526-2098
(303) 498-1100

Research

The RNA represents vegetation typical of the higher southwest canyon country. Sommers et al. (1980) has extensive baseline information on the RNA.

Publications

Kelly, G. W. 1947. The Narraguinnep Natural Area. The Green Thumb. 4: 12–14. (Publication of Denver Botanic Gardens.)

Sommers, P.; Nichols, G.E.; Stransky, R.W. 1980. Baseline ecological study of Narraguinnep Research Natural Area, San Juan National Forest. 23 p. (On file at the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.)

SADDLE MOUNTAIN RESEARCH NATURAL AREA

Location

Saddle Mountain RNA is located in Park County, Colorado, 11 miles southwest of the town of Lake George and 16 miles northwest of Cripple Creek, in the Pike and San Isabel National Forests, South Park Ranger District. The site is located in sections 8 and 17, Township 14 South, Range 72 West, 6th Principal Meridian.

To reach the RNA, travel approximately 32 miles northwest on Colorado State Highway 9, then turn right (north) onto County Road 102. After approximately 5 miles, turn left (north) onto County Road 59 and drive about 3.5 miles. From there, the RNA can be reached by hiking about 0.5 miles east cross-country (fig. 1).

Overview

The most significant feature of Saddle Mountain RNA is the excellent pristine montane grasslands (fig. 2). The RNA contains 194 hectares of Engelmann spruce (*Picea engelmannii*) and aspen (*Populus tremuloides*) stands interspersed with grasslands dominated by Parry oatgrass (*Danthonia parryi*).

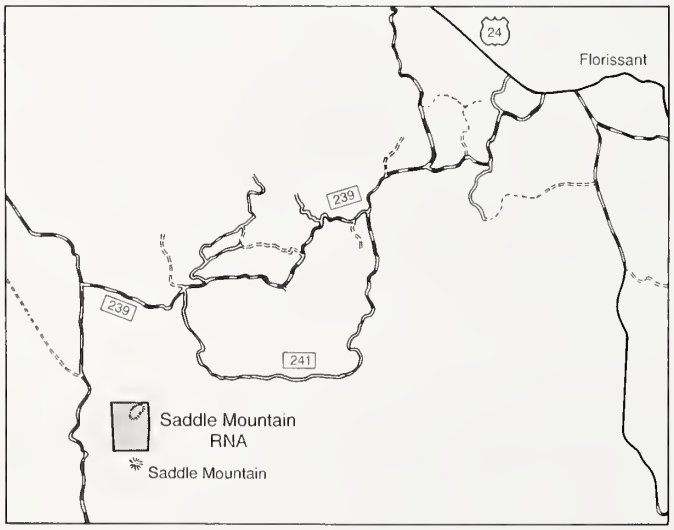

Figure 1. — Map of Saddle Mountain RNA and vicinity.

Figure 2. — Saddle Mountain RNA.

Climate

NOAA data on mean monthly precipitation at the nearest weather station, Lake George (elevation 2595 meters), show an average annual precipitation of 322 millimeters and an average annual temperature of 3°C (fig. 3). Average annual monthly maximum temperature is 12°C, and average annual monthly minimum temperature is –5°C.

Physiography, Geology, and Soils

Altitudes on this RNA range from 2775–3050 meters above sea level and slopes from gentle to as

much as 60%. The area's soil is derived from basalt and is typical of much of the southwestern portion of Pike National Forest and many other areas in southern Colorado.

Flora

A range survey done in 1946, before the area was designated as an RNA, reports 45 hectares of grassland, 45 hectares of aspen (*Populus tremuloides*), and 113 hectares of Engelmann spruce (*Picea engelmannii*). Grassland types were recovering from varying degrees of grazing use in 1951; sizeable areas were apparently reaching Parry oatgrass mix, rather than a cover type dominated by Arizona fescue (*Festuca arizonica*) and mountain muhly (*Muhlenbergia montana*). Parry oatgrass is a highly palatable climax grass species. Engelmann spruce and aspen timber types, as well as old stumps indicating former stands of large Douglas-firs (*Pseudotsuga menziesii*), occur on all but the southern and southwestern exposures. Fire, logging, and Dendroctonus infestation—singly and in combination—have been involved in this change. Various stages of invasion of the grasslands by aspen and bristlecone pine (*Pinus aristata*) were reported.

In 1985, a Forest Service employee reported that there appeared to be two different Parry oatgrass associations on this site:

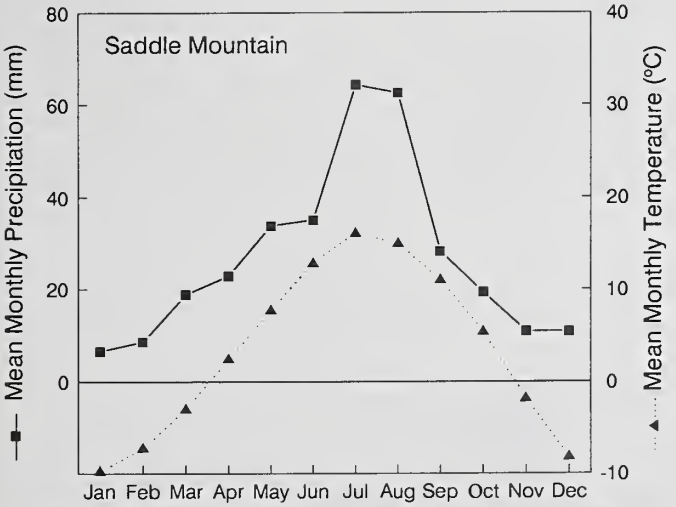

Figure 3. — Long-term average of mean monthly temperature and precipitation (from NOAA records) for the weather station closest to Saddle Mountain RNA. Data were taken from Lake George, CO, weather station, which is at an elevation of 2595 meters. The elevation of the RNA ranges from 2775–3050 meters, so actual climate at the RNA will likely be quite different from that shown. Precipitation was averaged over 36 years, and temperature was averaged over 32 years.

1) A Parry oatgrass-mountain muhly (*Muhlenbergia montana*) association occurs on the RNA's rockier south-trending slopes of up to 25% with elevations from 2775–2835 meters. Soils are derived from volcanic bedrock and are relatively shallow, moderately fertile, and generally rocky.
2) From the saddle downward to the valley bottom, the dominant plant association is Parry oatgrass-needleleaf sedge (*Carex eleocharis*). Exposure is easterly at 2775–2805-meter elevations. Volcanic soils are deep, fertile, and well drained. The most notable vegetation difference from the valley bottom to the adjacent grazed sites is the marked reduction in Parry oatgrass. American vetch (*Vicia americana*), needleleaf sedge, and Arizona fescue (*Festuca arizonica*) also decreased under grazing. Along the same gradient, there is a sizeable increase in mountain muhly, rose pussytoes (*Antennaria rosea*), muttongrass (*Poa fendleriana*), and squirrel-tail (*Sitanion hystrix*).

The establishment record, which is on file at the Rocky Mountain Forest and Range Experiment Station in Fort Collins, Colorado, contains lists of shrubs, grasses, and forbs for these plant associations.

Fauna

Mule deer (*Odocoileus hemionus*) are present, and use by elk (*Cervus elaphus*) in the fall to early winter was reported in 1985. The habitat is also suitable for rabbits and grouse, and the population of porcupine (*Erethizon dorsatum*) was reported to be high in 1951. Much of the grassland is too steep and too far from water to be grazed by livestock. Portions of the area were grazed year-round until a few years prior to 1951, and until 1951, only summer grazing occurred. It has not been grazed by domestic livestock since 1951, except for the occasional animal that wanders onto the RNA.

Status and Administration

Saddle Mountain was designated a Research Natural Area in March 1951 and is managed under special management prescription 10A of the Pike and San Isabel National Forest Plan. The South Park Ranger District (Fairplay, CO 80440, 303-836-2031) has responsibility for administration and protection of the RNA. Saddle Mountain was designated a scientific natural area by the Colorado Natural Areas Program in October 1980.

For information on conducting research on the RNA, contact:

Research Natural Area Coordinator
Rocky Mountain Forest and Range
Experiment Station
240 West Prospect Road
Fort Collins, CO 80526-2098
(303) 498-1100

Research and Publications

Saddle Mountain contains an excellent expanse of pristine montane grassland. Very few similar areas exist on Colorado's Front Range. Similar, grazed vegetation is available nearby for comparison. Additionally, the site is suitable for studying the invasion of grasslands and succession. We found no published studies of the RNA.

SHELL CANYON RESEARCH NATURAL AREA

Location

Shell Mountain RNA is located by air 18 miles northwest of Greybull, Wyoming, and 6 miles northeast of Shell, Wyoming, in Bighorn County, Paintrock Ranger District, Bighorn National Forest. The area lies within sections 10, 11, 14, 15, and 16 of Township 53 North, Range 90 West, 6th Principal Meridian. The approximate center of the RNA is at 44 34'37" North latitude, 107 39'51" West longitude.

To reach the RNA, take U.S. Highway 14 east 8 miles from the town of Shell, Wyoming, to the Post Creek Picnic Ground, the only place along this highway where vehicles can leave the road (fig. 1). The highway runs somewhat more than 200 feet from the northern boundary of the RNA. From the picnic ground, several undeveloped trails lead into the RNA.

Overview

The 295-hectare Shell Canyon site was the first RNA in the United States established primarily because of its Rocky Mountain juniper (*Juniperus scopulorum*) community (fig. 2). Most sites with Rocky Mountain juniper have been disturbed by grazing and logging for fenceposts, but the community in Shell canyon is in good condition. An extensive survey of northern Wyoming showed that this area shows the fewest effects from human disturbance, which would unnaturally alter vegetation and its succession. Above the juniper stands are stands of Douglas-fir (*Pseudotsuga menziesii*) on steep slopes, alternating with light-colored limestone rock outcrops and cliffs. The area is highly scenic and contains a number of outstanding geological features. It contains at least one site that has potential for reintroducing peregrine falcons and also has several populations of plant species endemic to the western flank of the Bighorn Mountains. The RNA is drained by two intermittent creeks, Post Creek and Shell Creek.

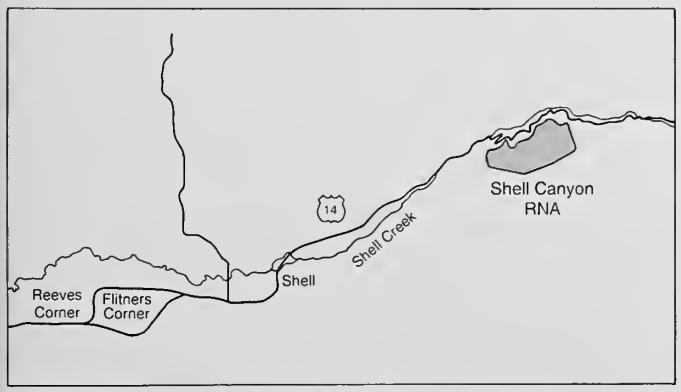

Figure 1. — Location of Shell Canyon RNA.

Climate

The climate of the area is characterized by hot dry summers and cool dry winters. These lower slopes of the Bighorn Mountains are in a rain shadow of the Absaroka, Wind River, and Teton mountains to the west and, therefore, have reduced precipitation. Average annual precipitation at the western foot of the Big Horns is 195 millimeters/year; it is probably slightly higher at Shell Creek. Most of the precipitation comes as rain or wet snow in April, May, and June (38% of the total), with a secondary peak in September and October (20% of the total). Average temperature is 8°C, with a high monthly peak of 22°C in late July. The coldest month is January, averaging –7°C. These data are based on an average of the records from Lovell, Hyattville, and Tensleep, in order to approximate the climate at the western base of the Bighorns.

Physiography, Geology, and Soils

Steep, north-facing limestone cliffs dominate the site. Below these cliffs are steep, timbered slopes, and below the slopes is a terrace that slopes relatively gently to the north and northwest. The terrace gives way to the steep gorge of Shell Canyon, which is beyond the northern boundary of the RNA. The tops of the cliffs that form the southern boundary of the area vary from 2025–2285 meters in elevation. The terrace below the cliffs varies from 1494 meters at the northwest corner of the RNA to about 1844 meters at the southeastern end of the terrace.

The Bighorn Mountains were uplifted during the Eocene Epoch, and now form an anticlinal massif, with an older granite central plateau and younger

Figure 2. — Shell Canyon RNA (photograph by Barry C. Johnston).

sedimentary rocks on the flanks of the range. The area contained within Shell Mountain RNA was formed from the cutting of Shell Creek through the Madison limestone (Mississippian) and the older Bighorn dolomite (Ordovician), as well as by subsequent mass movement and landslides. The soils of the area are generally loams and gravelly silt loams; rock outcrops are common.

The soils have been classified as either Grobutte Series, which supports Rocky Mountain juniper (*Juniperus scopulorum*) and sagebrush (*Artemisia* spp.), or Cloud Peak Series, which supports Douglas-fir (*Pseudotsuga menziesii*). A small part of the western edge of the area is classified as the Starman Series, which supports a sparse stand of curl-leaf mountain mahogany (*Cercocarpus ledifolius*) on very steep slopes.

Flora

There are three distinct, conspicuous plant associations in the RNA, two associations of smaller acreage and a conspicuous acreage of rock outcrops and cliffs. The three major plant associations are described below.

1) Douglas-fir (*Pseudotsuga meuziesii*)-mountain ninebark (*Physocarpus monogynus*) plant association. This closed canopy Douglas-fir forest occurs on steep northeasterly slopes between and just below the limestone cliffs. This plant association is fairly common on the lower west flanks of the Bighorn Mountains on limestone-derived soils and northerly 36–45% slopes, at elevations of 1585–2010 meters. Commonly associated species include Douglas-fir, mountain ninebark, mountain snowberry (*Symphoricarpos oreophilus*), prickly rose (*Rosa acicularis*), and mosses. Douglas-fir stands in this area are very near climax. Limber pine (*Pinus flexilis*) and Rocky mountain juniper are commonly associated trees, along with common juniper (*Juniperus communis*), white spiraea (*Spiraea betulifolia*),

Oregon grape (*Berberis repens*), heartleaf arnica (*Arnica cordifolia*), and northern bedstraw (*Galium boreale* ssp. *septentrionale*). Grasses and forbs are typically sparse.

2) Rocky Mountain juniper-bluebunch wheatgrass (*Agropyron spicatum*) plant association. This juniper woodland occurs on moderate to steep lower slopes between the Douglas-fir forest above and the sagebrush on the terrace below. Within the RNA, this plant association is dominated by Rocky Mountain juniper and bluebunch wheatgrass, with curl-leaf mountain mahogany (*Cercocarpus ledifolius*) a conspicuous codominant. There are occasional isolated Douglas-firs and limber pines. Common associates are mountain snowberry, Ross sedge (*Carex rossii*), junegrass (*Koeleria pyramidata*), Geyer onion (*Allium geyeri*), stemless goldenweed (*Stenotus acaulis*), moss phlox (*Phlox muscoides*), and fleabane (*Erigeron* spp.).
3) Black sagebrush (*Artemisia arbuscula*)-bluebunch wheatgrass (*Agropyron spicatum*) plant association. These moderately low sagebrush stands occur on benches and shallow slopes between the juniper forest above and the canyon of Shell Creek below. This association is fairly common at lower elevations in northwestern Wyoming and southern Montana on moderately shallow soils where precipitation is below 381 millimeters/year. Common species in this association include black sagebrush, bluebunch wheatgrass, and junegrass. Occasionally, isolated mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) plants or winterfat (*Eurotia lanata*) can be found.

In addition to these major plant associations, smaller acreages are covered by curl-leaf mountain mahogany-bluebunch wheatgrass plant association. This is an open shrubland occupying very steep, rocky slopes and is more common west of the RNA. Common plants include curl-leaf mountain mahogany, bluebunch wheatgrass, black sagebrush, and prairie junegrass.

The one small patch of grassland is dominated by western needlegrass (Stipa occidentalis) and western wheatgrass (*Agropyron smithii*), with smaller amounts of giant wildrye (*Elymus cinereus*) and currant species (*Ribes* spp.). The establishment record, on file at the Rocky Mountain Forest and Range Experiment Station in Fort Collins, Colorado, contains more complete lists of plants found on the RNA.

Fauna

Mule deer (*Odocoileus hemionus*) are common in the area in the wintertime. The area is important winter range, with Douglas-fir stands providing valuable hiding and thermal cover. Elk (*Cervus elaphus*) also use the area as winter range, but to a lesser extent than mule deer. Bighorn sheep (*Ovis canadensis*) have recently been reestablished in the vicinity. Shell Canyon is currently among the sites that "should be periodically surveyed for nesting peregrine falcons." The RNA may contain a site for potential reintroduction of peregrines.

Status and Administration

Shell Canyon was designated a Research Natural Area in June 1987. It is administered under special management provision 10A, Bighorn National Forest Plan. The Paintrock Ranger District (Greybull, WY 82426, 307-765-4435) has responsibility for administration and protection of the RNA.

For information on conducting research on the RNA, contact:

Research Natural Area Coordinator
Rocky Mountain Forest and Range
Experiment Station
240 West Prospect Road
Fort Collins, CO 80526-2098
(303) 498-1100

Research and Publications

The area is suited to studies of Rocky Mountain juniper populations that have been relatively unimpacted by grazing and logging. The Paintrock Ranger District planned to reintroduce bighorn sheep to Shell Canyon in 1993. We found no publications from the RNA.

SHEYENNE SPRINGS RESEARCH NATURAL AREA

Location

Sheyenne Springs RNA is located in southeastern North Dakota, 48 miles southwest of Fargo, North Dakota, along the Sheyenne River as it passes through the Sheyenne sandhills in Ransom County. It is part of the Sheyenne National Grassland of the Custer National Forest and is administered by the Sheyenne Ranger District. The RNA is located in Section 2 of Township 135 North, Range 53 West, 5th Principal Meridian. The center of the RNA lies at 46 32'10" North latitude and 97 18'30" West longitude.

To reach the RNA from Lisbon, North Dakota, proceed 16 miles west on State Highway 27, and then 7.5 miles in a mainly northerly direction on County Road FAS 3733 (gravel) to a gated entry at the SW 1/4 of Section 2 (fig. 1). Turn right (east) at the gated entry and proceed east along the unimproved two-track road until the treeline marking the west edge of the RNA is reached. There are no trails within the RNA except for game trails and an impassible abandoned primitive road that once ran along the western edge of the wetland.

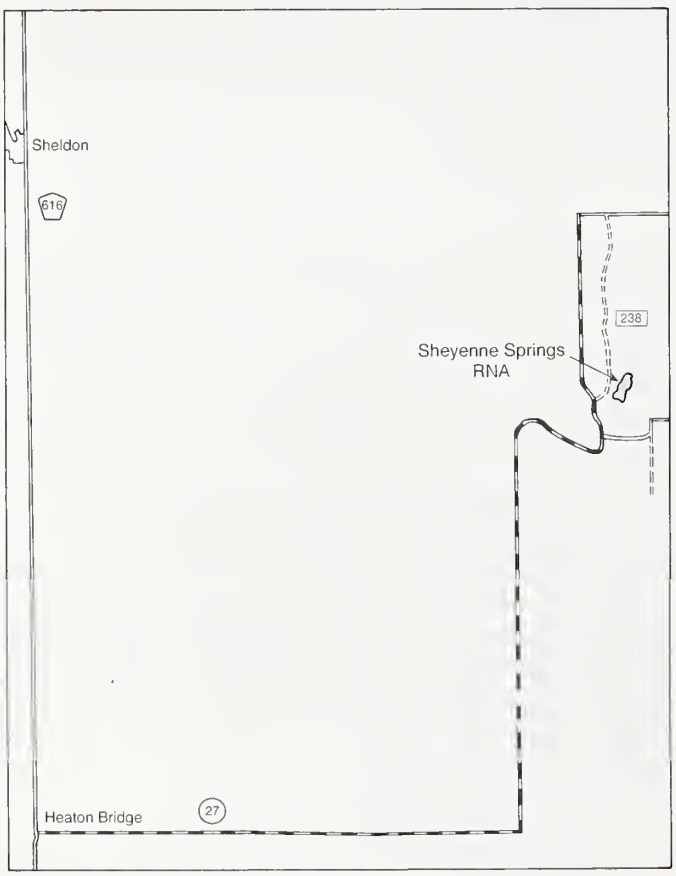

Figure 1. — Location of Sheyenne Springs RNA.

Overview

The 23-hectare RNA is a spring-fed wetland complex that has been protected from livestock grazing since 1974 and is noted for its abundant wildlife (fig. 2). Beaver (*Castor canadensis*) are very active in the RNA and significantly shape the ecosystem with dams and ponds. The wetland complex represents a number of undisturbed, highly restricted, specialized aquatic habitats and their characteristic flora and fauna; its most extensive habitat is calcium carbonate peat wetland, or fen. Sheyenne Springs is among the 10 most significant wetland sites in the North Dakota in terms of its total number of rare species. It hosts the highest known number of state rare species in North Dakota—including 18 rare species that are considered relicts, with a boreal affinity more closely resembling the paleoflora immediately after the lowering of glacial Lake Agassiz.

Climate

Southeastern North Dakota has among the highest mean annual precipitation levels of the state, with 509 millimeters at the nearest monitoring station in Lisbon, about 20 miles southwest of the RNA at an elevation of 332 meters. The length of record is 90 years (1992). About 70% of the precipitation occurs between April and August. Most summer rainfall originates with thunderstorms and is highly variable in area and magnitude. The average maximum temperature is 12°C; the average minimum temperature is –2°C.

Effective climatic conditions vary greatly with slope, aspect, and topographical position. Particularly important in the Sheyenne Sandhills are substrate and depth to groundwater. Upland microclimates can become droughty in contrast to areas with stable groundwater discharges as found along the Sheyenne River as it crosses the sandhills. These ex-

Figure 2.—Large Beaver Pond in Sheyenne Springs RNA (photograph by Angela Evenden).

tremes in local microclimates are represented within the RNA.

Physiography, Geology, and Soils

Elevations within the RNA range from 300 meters at the stream on the lower end of the site to 335 meters at the highest sandhill along the west-central border. The RNA is a small valley above the Sheyenne River, representing a spring-fed wetland system of stable Sheyenne Delta aquifer discharge. It is a peatland stream complex interrupted by beaver impoundments and surrounded by woodland.

North Dakota's Sheyenne Sandhills were formed from an enormous delta at the mouth of the Sheyenne River when it carried glacial meltwater into glacial Lake Agassiz. This glacial deposit is the largest on the continent and is not typical of the prevailing fine-textured deposits that make up the rest of the glacial lakebed that is referred to as the Red River Valley. The deltaic deposits in the RNA overlie the Belle Fourche Formation bedrock, buried 215–245 meters below the surface.

Gently rolling sheet-deposit sandplains (Holocene Formation) cover much of the Sheyenne Sandhills. In limited areas, the sands have been reworked by winds into low-relief sand dunes and into localized high-relief sand dunes with over 25 meters of relief. This setting is dissected by the Sheyenne River and fine-textured alluvium (the Oahe Formation) deposited on the valley floor. Glacial Lake Agassiz advanced and retreated more than once, so deposits underlying the Sheyenne Sandhills are heterogeneous. In high-water intervals, the lake levels rose and fine deposits of silts and clays overlaid the sand, later to be buried again in sand when the lake level dropped. The less porous silt and clay deposits closest to the surface make up the Sheyenne Delta Aquifer; the water table is usually less than 3 meters below the upland surface.

Most of the soils of the RNA are peat—anaerobic soils made up of unconsolidated plant deposits that

are waterlogged and poorly drained. Upland soils are the Serden stabilized dune complex, making an abrupt transition from lowlying peat soils. Upland soils are fine sands or fine loamy sands.

Flora

Sheyenne Springs RNA contains the following plant associations: bog birch-water sedge (*Betula glandulosa-Carex aquatilis*), alder-jewelweed (*Alnus rugosa-Impatiens capensis*), willow/red-osier dogwood (*Salix discolor-Cornus stolonifera*), slough sedge (*Carex atherodes*), reed canary-grass (*Phalaris arundinacea*), water crowfoot (*Ranunculus aquatilis*), slough grass-American manna grass emergents (*Beckmannia syzigachne-Glyceria maxima* ssp. *grandis*), aspen-wild sarsaparilla (*Populus tremuloides-Aralia nudicaulis*), bur oak-chokecherry (*Quercus macrocarpa-Prunus virginiana*), green ash-sedge (*Fraxinus pennsylvanica-Carex sprengelii*), green ash-basswood (*Fraxinus pennsylvanica-Tilia americana*), and big bluestem-prairie sand-reed (*Andropogon gerardii-Calamovilfa longifolia*).

Of 853 species that have been documented from North Dakota's three southeastern counties, 150 are known from within the enclosure forming the RNA boundary. Many of these are wetland species. No federally listed threatened or endangered species are known to exist on the RNA. Twelve state rare vascular plant species are documented in the RNA. They are: lady fern (*Athyrium filixfemina*), marsh bellflower (*Campanula aparinoides*), delicate sedge (*Carex leptalea*), yellow lady's slipper orchid (*Cypripedium calceolus* var. *parviflorum*), showy lady's slipper orchid (*Cypripedium reginae*), crested woodfern (*Dryopteris cristata*), spinulose woodfern (*Dryopteris spinulosa*), marsh horsetail (*Equisetum palustre*), western wahoo (*Euonymus atropurpureus*), bog bedstraw (*Galium labradoricum*), buckbean (*Menyanthes trifoliata*), and marsh fern (*Thelypteris thelypteroides*). Other uncommon species are *Carex prairea*, *Clematis ligusticifolia*, *Eupatorium perfoliatum*, and *Osmorhiza claytonii*, and a rare liverwort (*Ricciocarpus natans*) has been collected floating on the flowing stream.

It is noteworthy that Sheyenne Springs is among the few places in the Sheyenne National Grassland where four of the eight rare Sheyenne Sandhills ferns and fern allies grow together. The occurrences of marsh horsetail and delicate sedge are also significant in that the former is among the biggest population of the species in the state and the latter had not been collected in the sandhills area for 50 years until recent inventory work. The peatland also has a rich bryophyte flora, but mosses have not been studied at the site to date.

An extensive list of trees, shrubs, graminoids, forbs, ferns, and fern allies found on the RNA is included in the establishment record, which is on file at the Rocky Mountain Forest and Range Experiment Station in Fort Collins, Colorado.

Fauna

To date, a total of 64 bird species are believed to breed at the site, including five game species: mallard (*Anas platyrhynchos*), blue-winged teal (*Anas discors*), wood duck (*Aix sponsa*), wild turkey (*Meleagris gallopavo*), and mourning dove (*Zenaida macroura*). Five of the RNA's breeding species are considered by the North Dakota Natural Heritage Inventory to be rare in the state: western wood-pewee (*Contopus sordidulus*), pileated woodpecker (*Dryocopus pileatus*), scarlet tanager (*Piranga olivacea*), American woodcock (*Scolopax minor*), and eastern bluebird (*Sialia sialis*). A complete list of birds sighted at the RNA is contained in the establishment record.

Mammals observed and believed to breed at the site include white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), red squirrel (*Tamiasciurus hudsonicus*), badger (*Taxidea taxus*), and beaver. A population of Sheyenne Sandhills moose (*Alces alces*) is also known to have used the wetland habitat at least two winters in recent years.

Amphibians and reptiles have not been inventoried at the site. The gray tree frog (*Hyla versicolor*), which is presently on the list of state rare animals (compiled by the North Dakota Natural Heritage Inventory), has been photographed there.

Fish and mollusks, including several state rare species, may be associated with the spring-fed stream discharge below the enclosure, but free-flowing stream habitat is rare within the boundaries. Nevertheless, the high volume of spring discharge emitted from the enclosure makes it important for maintaining local fisheries and water quality by providing cool, stable conditions. Rare fish of the lower Sheyenne River include the hornyhead chub (*Nocomis biguttatus*), greater redhorse (*Moxostoma valenciennesi*), pugnose shiner (*Notropis anogenus*), and blacknose shiner (*Notropis heterolepis*). Rare mussels of the lower Sheyenne River include at least the pigtoe mussel (*Fusconaia flava*), black sand-shell mussel (*Ligumia recta*), and pink heelsplitter mussel (*Potamilus alatus*).

Butterflies and other insects have not been inventoried on the site. Butterflies that are rare in the state have been documented from wetland habitats in the nearby Mirror Pool Wildlife Management Area. Upland habitat immediately northeast of the site has been the collection point of *Hesperia dacotae*, a butterfly considered as a candidate for federal listing.

Status and Administration

Sheyenne Springs was designated a Research Natural Area in March 1992. It is managed under special management prescription 10A, Custer National Forest Plan. The Sheyenne Ranger District (Lisbon, ND 58054, 701-683-4342) is responsible for administration and protection of the RNA.

For information on conducting research on the RNA, contact:

Research Natural Area Coordinator
Rocky Mountain Forest and Range
Experiment Station
240 West Prospect Road
Fort Collins, CO 80526-2098
(303) 498-1100

Research

The RNA is an appropriate site for research involving wetlands, especially the fen type, as well as research involving any of the rare plant and animal species found on the RNA.

Publications

North Dakota Parks and Recreation Department. 1990. Inventory of rare plant species in the Sheyenne National Grassland, Ransom and Richland Counties, North Dakota. Bismarck, ND: North Dakota Parks and Recreation Department.

Seiler, G.J. 1973. Vascular flora of Richland, Ransom and Sargent counties, North Dakota. Fargo, ND: North Dakota State University. 192 p. M.S. thesis.

Seiler, G.J.; Barker, W.T. 1985. Vascular flora of Richland, Ransom and Sargent counties, North Dakota. Prairie Naturalist. 17(3): 193–240.

Thompson, D.G; Joos, L.L. 1975. Soil survey of Richland County and the Sheyenne National Grassland area of Ransom County. Bismarck, ND: U.S. Soil Conservation Service and Forest Service, in cooperation with North Dakota Agricultural Experiment Station.

SIGNAL HILL RESEARCH NATURAL AREA

Location

Signal Hill RNA is located 10 miles southwest of Halsey, Nebraska, in Thomas County, Bessey Ranger District of the Nebraska National Forest. The RNA occupies portions of sections 3, and 4, Township 21 North, Range 27 West, 6th Principal Meridian. Approximate latitude is 41 48' North; approximate longitude is 100 24' West.

To reach Signal Hill, travel east from Thedford, Nebraska, on State Highway 2 for approximately 15 miles. One mile west of the town of Halsey, take a right at a national forest sign; cross railroad tracks and the Middle Loup River, then take a right after a cattleguard onto Forest Service Road 86B. The Bessey Ranger District office is 0.25–0.50 miles on the left. Pass the office and continue toward the lookout tower. On the left is a gravel road marked "203 East." Follow this road until approximately mile marker 12, then take a right at a gate and go 0.5 miles. The RNA lies at the highest point in the ranger district (fig. 1).

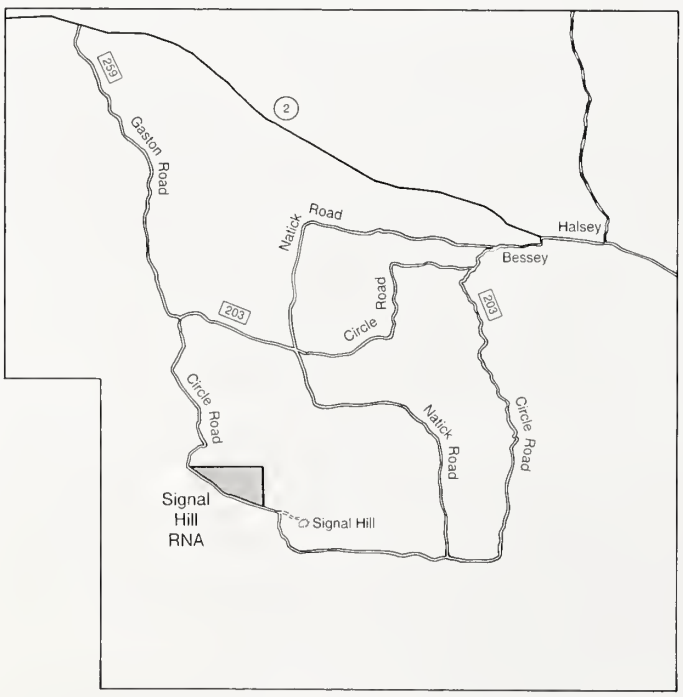

Figure 1. — Location of Signal Hill RNA.

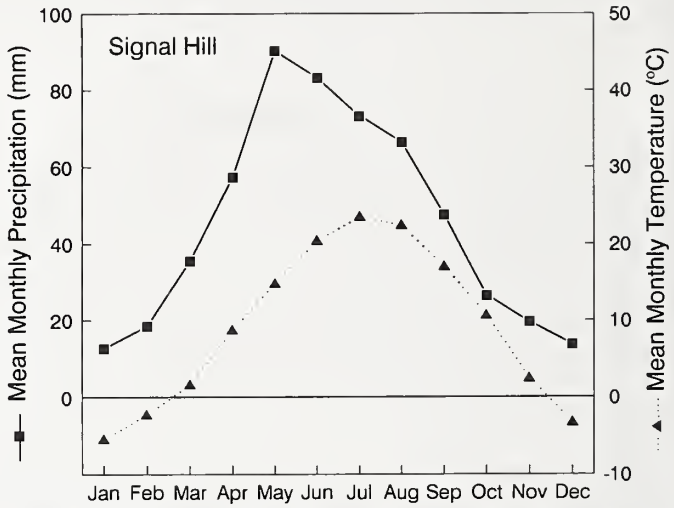

Figure 2. — Long-term monthly average of mean temperature and precipitation for the NOAA weather station closest to Signal Hill RNA. Data were taken from the Purdum, NE, weather station, which is at an elevation of 820 meters. The elevation of the RNA ranges from 860–885 meters, so actual climate at the RNA will likely be similar to that shown. Precipitation and temperature were averaged over 43 years.

Overview

Signal Hill RNA consists of approximately 283 hectares of Nebraska sandhills prairie in the drainage of the Middle Loup River. The tract is representative of the rougher sandhill-type terrain bordering rivers in the state's sandhills area and reflects natural vegetative growth and trends of the approximately 51,800 square kilometers of land that lie north of the Platte River and west of the middle line of Holt and Greeley Counties, Nebraska—approximately one-quarter of the entire state. Elevations in the Signal Hill RNA range from 860–885 meters above sea level.

Climate

Average annual precipitation at the weather station nearest the RNA is 545 millimeters. Precipitation is well distributed throughout the year, although heavier in May, June, and July, with September, October, and November being regarded as the dry months (fig. 2). The average annual temperature is 9°C. Average annual monthly maximum temperature

is 17°C; average annual monthly minimum temperature is 1°C. High velocity winds occur most frequently in the winter and spring months; the annual average for wind velocity is 18 kilometers per hour.

Physiography, Geology, and Soils

The RNA's terrain is one of choppy hills or sand dunes that support a good vegetative cover. The dunes in the vicinity of the site are described by geologists as being the youngest of the hills in the area and are still affected by wind, although the 1950 establishment record indicated that the dunes had become more stable with the absence of trampling by herds of deer, elk, and buffalo. The site's soil is practically pure silica, containing less than 1% organic matter. There are no lakes or streams in the RNA; it is an intermingled composition of dunes and small valleys without drainage.

Flora

The establishment record listed the area's dominant cover type as sandhills grassland. Sand lovegrass (*Eragrostis hallii*) is characteristic of the north slopes and some of the swales. Sandhill bluestem (*Andropogon chrysocomus*) is a common pioneer in blowouts and on steep south slopes. Prairie sandreed (*Calamovilfa longifolia*) is abundant over a wide range of habitats. Other characteristic grasses also found in the area include little bluestem (*Schizachyrium scoparius*), blowout grass (*Redfieldia flexuosa*), Indian grass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), sandhill muhly (*Muhlenbergia pungens*), needle-and-thread (*Stipa comata*), and sedge (*Carex heliophila*).

Important mixed prairie species observed are western wheatgrass (*Agropyron smithii*), blue grama (*Bouteloua gracilis*), hairy grama (*B. hirsuta*), green needlegrass (*Stipa viridula*), and red threeawn (*Aristida longiseta*). The shrub communities within the RNA constitute a desirable feature, since in many other locations, these forms have been killed by overgrazing. Present in considerable numbers are wild plum (*Prunus americana*), choke cherry (*P. virginiana*), New Jersey tea (*Ceanothus herbaceus*), sand cherry (*P. besseyi*), lead plant (*Amorpha canescens*), rose (*Rosa arkansana*), yucca (*Yucca glauca*), and poison ivy (*Toxicodendron radicans*).

Fauna

Except for an occasional mule deer (*Odocoileus hemionus*) and pronghorn antelope (*Antilocapra americana*), there are no species of big game in the area. The area was heavily populated with coyotes (*Canis latrans*) in 1950. Sharptailed grouse (*Tympanuchus phasianellus*) and greater prairie chicken (*Tympanuchus cupido*) are found in the area. Other wildlife in the area include rattlesnakes, rabbits (scarce), Ord's kangaroo rats (*Dipodomys ordii*), porcupines (*Erethizon dorsatum*), and plains pocket gophers (*Geomys bursarius*).

Status and Administration

Signal Hill Research Natural Area was designated in May 1950. It is managed under special management prescription 10A of the Nebraska National Forest Plan. Bessey Ranger District (Halsey, NE 69142, 308-533-2257) has responsibility for administration and protection of the RNA.

For information on conducting research on the RNA, contact:

Research Natural Area Coordinator
Rocky Mountain Forest and Range
Experiment Station
240 West Prospect Road
Fort Collins, CO 80526-2098
(303) 498-1100

Research and Publications

Signal Hill is an appropriate site for research involving the ecology of the Nebraska Sandhills. We found no published studies on the RNA.

SNOWY RANGE RESEARCH NATURAL AREA

Location

Snowy Range RNA is located 6 miles northwest of Centennial, Albany County, Wyoming, in the Laramie Ranger District of the Medicine Bow National Forest. The RNA is contained in portions of sections 13, 14, 15, 22, 23, and 24, Township 16 North, Range 79 West, 6th Principal Meridian, at 41 21' North latitude and 106 14' West longitude. To reach this RNA, travel 37 miles west of Laramie and 6 miles northwest of Centennial on State Highway 130. At the Libby Creek Recreation Area, continue to the right to the Greenrock Picnic Ground. A curlicue of roads west of the picnic area lead into the RNA; the highway passes within 60 meters of the RNA at the closest point (fig. 1).

Overview

Snowy Range RNA comprises 312 hectares of mixed Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) forest (fig. 2). Much of the Medicine Bow National Forest was cut over for ties at the time the Union Pacific Railroad was constructed. Certain small areas of the dominant spruce-fir timber that grew at higher elevations were passed by; this may have been due to location or because the railroad preferred lodgepole pine (*Pinus contorta*) for their ties. The Snowy Range RNA has not been logged, although the lodgepole pine growing within 3 miles of the area has been cut.

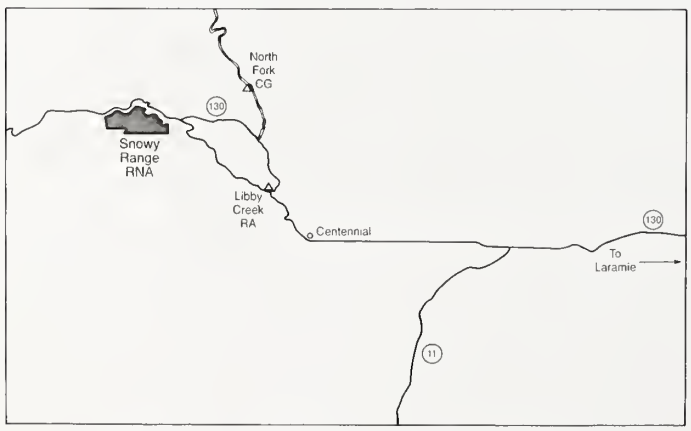

Figure 1. — Location of Snowy Range RNA.

Climate

At the weather station nearest the RNA, average annual precipitation is 364 millimeters, and the average annual temperature is 5°C (fig. 3). The average annual monthly maximum temperature is 12°C; the average annual minimum temperature is 2°C. There is no average frost-free period. Weather data is available for the nearby Glacier Lakes Ecosystem Experiment Site (GLEES) for recent years (Musselman 1994).

Physiography, Geology, and Soils

The general aspect of the area is rolling, and the predominant slope is to the northeast. It is drained by Nash Fork Creek along its northern border and Sally Creek through its center; both creeks are part of the Little Laramie River drainage. There are three small lakes; the largest is Swastika Lake. Elevations on the site range from approximately 2985 meters above sea level in the southeast corner to 3230 meters in the westernmost reaches.

The soils are typical for the elevation and general location: thin, nonalkaline, and formed of weathered gneiss and an accumulation of decomposed coniferous litter. The slightly acid conditions of coniferous forests prevail, and podsolization is at a minimum.

Flora

The RNA consists of 216 hectares of mixed Engelmann spruce and subalpine fir and 83 hectares of lodgepole pine. In addition, there are approximately 4 hectares of grassland and 4 hectares of shrubland, and approximately 5 hectares covered by lakes. A detailed vegetation survey has not been completed for Snowy Range.

Fauna

Small animals are abundant. Although mule deer (*Odocoileus hemionus*) is the only common big-game animal, an occasional elk (*Cervus elaphus*) passes through this area. The ponds do not support fish.

Figure 2. — Snowy Range RNA.

Status and Administration

The site was designated as an RNA in January 1936. It is managed under special management prescription 10A of the Medicine Bow National Forest Plan. The Laramie Ranger District (Laramie, WY 82070, 307-745-8971) has responsibility for administration and protection of the RNA.

For information on conducting research on the RNA, contact:

Research Natural Area Coordinator
Rocky Mountain Forest and Range
Experiment Station
240 West Prospect Road
Fort Collins, CO 80526-2098
(303) 498-1100

Research

Snowy Range RNA has been used to study subalpine forests in pristine condition. The availablity of ex-

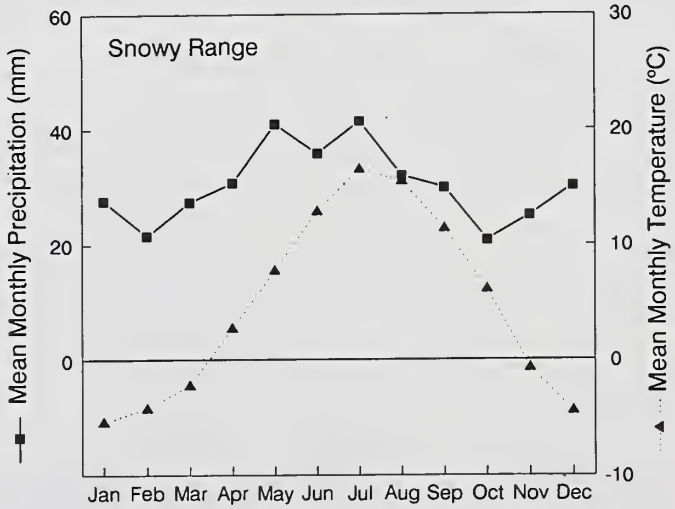

Figure 3. — Long-term average of mean monthly temperature and precipitation (from NOAA records) for the weather station closest to Snowy Range RNA. Data were taken from Centennial, WY, weather station, which is at an elevation of 2480 meters. The elevation of the RNA ranges from 2985–3230 meters, so actual climate at the RNA will likely be very different from that shown. Precipitation and temperature were averaged over 38 years.

tensive data from the nearby GLEES experimantal site increases the utility of Snowy Range as a research site.

Publications

Fichter, Edson. 1939. An ecological study of Wyoming spruce-fir forest arthropods with special reference to stratification. Ecological Monographs. 9(2): 183–215.

Hadley, J.L.; Smith, W.K. 1983. Influence of wind exposure on needle desiccation and mortality for timberline conifers in Wyoming, USA. Arctic and Alpine Research. 15: 127–135.

Hanna, L.A. 1934. The major plant communities of the headwater area of the Little Laramie River. University of Wyoming Publication, Botany. 1(10): 243–266.

Hansen, H.P. 1940. Ring growth and dominance in a spruce-fir association in southern Wyoming. American Midland Naturalist. 23: 442–447.

Knapp, A.K.; Smith W.K. 1981. Water relations and succession in subalpine conifers in southeastern Wyoming. Botanical Gazette. 142(4): 502–511.

Knapp, A.K. 1982. Factors influencing understory establishment of Engelmann spruce (Picea engelmannii) and subalpine fir (Abies lasiocarpa) in southeast Wyoming. Canadian Journal of Botany. 60: 2753–2761.

Musselman, R.C. 1994. The Glacier Lakes Ecosystem Experiment Site: an alpine global change research study area. Gen. Tech. Rep. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station [In Press].

Oosting, H.J.; Reed, J.F. 1952. Virgin spruce-fir of the Medicine Bow mountains, Wyoming. Ecological Monographs. 22: 6991.

Young, D.R.; Smith, W.K. 1982. Simulation studies of the influence of understory location and transportation and photosynthesis of Arnica cordifolia on clear days. Ecology. 63: 1761–1770.

TWO TOP AND BIG TOP MESAS RESEARCH NATURAL AREA

Location

Two Top and Big Top Mesas RNA is located in North Dakota badlands country 6 miles east of the Little Missouri River in the Magpie Creek drainage. Two Top Mesa is in the center of the S 1/2 of Section 10 and Big Top Mesa in the SE 1/4 of Section 9, Township 144 North, Range 101 West. Both mesas are within the Medora Ranger District of the Little Missouri National Grassland, which is part of the Custer National Forest. The RNA is located at 47 18' North latitude and 103 29' West latitude.

The RNA can be reached from Interstate 94 by going north on State Highway 85 from the Belfield interchange 22 miles to Magpie Road (fig. 1). Go east on this road 16 miles to Mr. Willis Northrup's turn in the center of Section 15, Township 144 North, Range 101 West. Go north 0.75 miles via a dry-weather country road to a gate at a saddle of a gentle divide between Big Top and Two Top; the mesas are a mile apart. The route to climb Big Top is on the mesa's northeast corner; the ridge at the southwest end of Two Top is best to climb. Both climbs are rough scrambles.

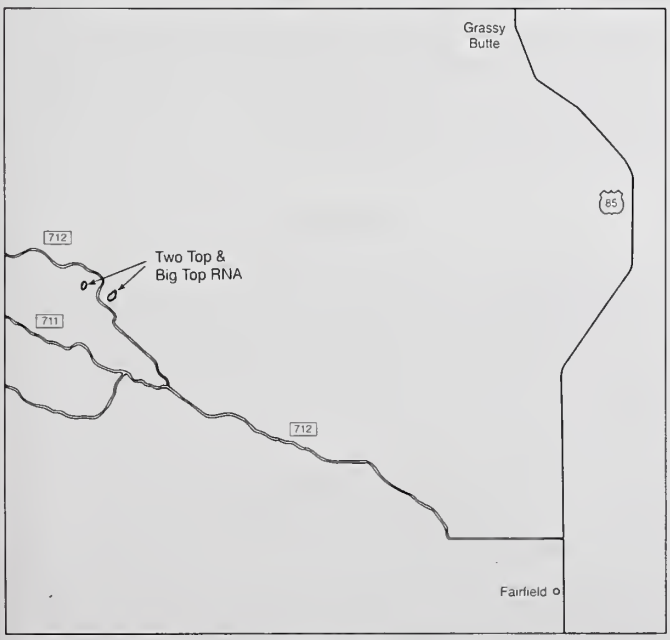

Figure 1. — Map of Two Top and Big Top Mesas RNA and vicinity.

Overview

Because of their steep sides, these badlands mesas are not accessible to livestock and support remnant examples of midgrass prairie grassland protected from grazing, fire, and other influences. The RNA encompasses 32 hectares, including 6 hectares of mesa tops (fig. 2).

Climate

Based on data from the nearest weather station in Fairfield, ND, the average annual temperature is 5°C, and the average annual precipitation is 386 millimeters (fig. 3). A large proportion of the precipitation falls between April and September, often in severe localized storms that can drop as much as 178 millimeters of rain and hail in a short time. Under drought conditions, precipitation as low as 152 millimeters/year has been recorded. Of 96 years recorded, 16 years had precipitation totals of less than 279 millimeters. More than 152 millimeters of snowpack exists on average only 22 days per year. This is a windy area, with prevailing winds from the northwest. The average frost-free period is May 20 to September 15.

Physiography, Geology, and Soils

These flat-topped, steep-sided mesas rise about 120 meters above the surrounding area. Elevation of both mesas is 975 meters above sea level. These mesas are remnants of a higher land level. All of the surrounding land has eroded away, leaving the mesas with their clay and sandstone escarpments and their Morton silt loam soil overlying clay loam at 0.75–1 meter soil depth.

Flora

A sampling of the midgrass prairie on the tops of the mesas yielded this composition: western wheatgrass (*Agropyron smithii*), 44%; blue grama (*Bouteloua gracilis*), 21%; thickspike wheatgrass (*Agropyron dasystachyum*), 14%; junegrass (*Koeleria pyramidata*), 5%; needle-and-thread (*Stipa comata*), 5%; threadleaf sedge (*Carex filifolia*), 2%; and green needlegrass (*Stipa*

Figure 2. — Big Top Mesa viewed from Two Top Mesa (photograph by Angela Evenden).

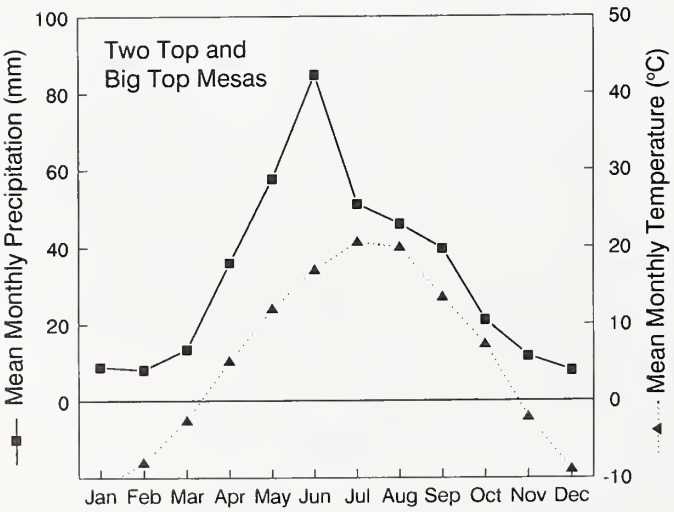

Figure 3. — Long-term average of mean monthly temperature and precipitation (from NOAA records) for the weather station closest to Two Top and Big Top Mesas RNA. Data were taken from the Fairfield, ND, weather station, which is at an elevation of 840 meters. The elevation of the RNA is 975 meters, so actual climate will likely be similar to that shown. Precipitation was averaged over 44 years, and temperature was averaged over 37 years.

viridula), 2%. Sedge (*Carex eleocharis*), pasture sagebrush (*Artemisia frigida*), blue-flowered lettuce (*Lactuca pulchella*), *Poa canbyi*, and plains reedgrass (*Calamagrostis montanensis*) are also present in lesser amounts. Many other less common species are given in Quinnild and Cosby (1958).

Fauna

The mesas are secondary habitat for white-tailed deer (*Odocoileus virginianus*). Other animals known to be present on the mesas include coyote (*Canis latrans*), badger (*Taxidea taxus*), rabbits, mice, and snakes.

Status and Administration

Two Top and Big Top Mesas RNA was designated a Research Natural Area in January 1973. It is administered under special management prescription 10A of the Custer National Forest Plan. The Medora

Ranger District (Dickinson, ND 58601, 701-225-5151) is responsible for administration and protection of the RNA.

For information on conducting research on the RNA, contact:

Research Natural Area Coordinator
Rocky Mountain Forest and Range
Experiment Station
240 West Prospect Road
Fort Collins, CO 80526-2098
(303) 498-1100

Research

The mesas are appropriate sites for studies involving midgrass prairie grassland in pristine condition and, especially, for comparison with nearby grazed areas.

Publications

Quinnild, C.L.; Cosby, H.E. 1958. Relicts of climax vegetation on two mesas in western North Dakota. Ecology. 39(1): 29–32.

UPPER PINE CREEK RESEARCH NATURAL AREA

Location

Upper Pine Creek RNA is located in Pennington County, South Dakota, 5 miles southeast of Hill City, South Dakota, in the Harney Ranger District of the Black Hills National Forest. The site lies at 43 52' North latitude, 103 30' West longitude. The RNA is located in portions of sections 10, 11, 15, 16, 21, and 22 of Township 2 South, Range 5 East, Black Hills Meridian.

To reach the RNA, travel south from Hill City on Highway 385 for approximately 3 miles to the intersection with Forest Service Road 244 (the road to Mount Rushmore). Turn east and go 4.5 miles to the Elkhorn Picnic Ground. From this picnic ground, moderate 1-mile trails lead to the RNA (fig. 1).

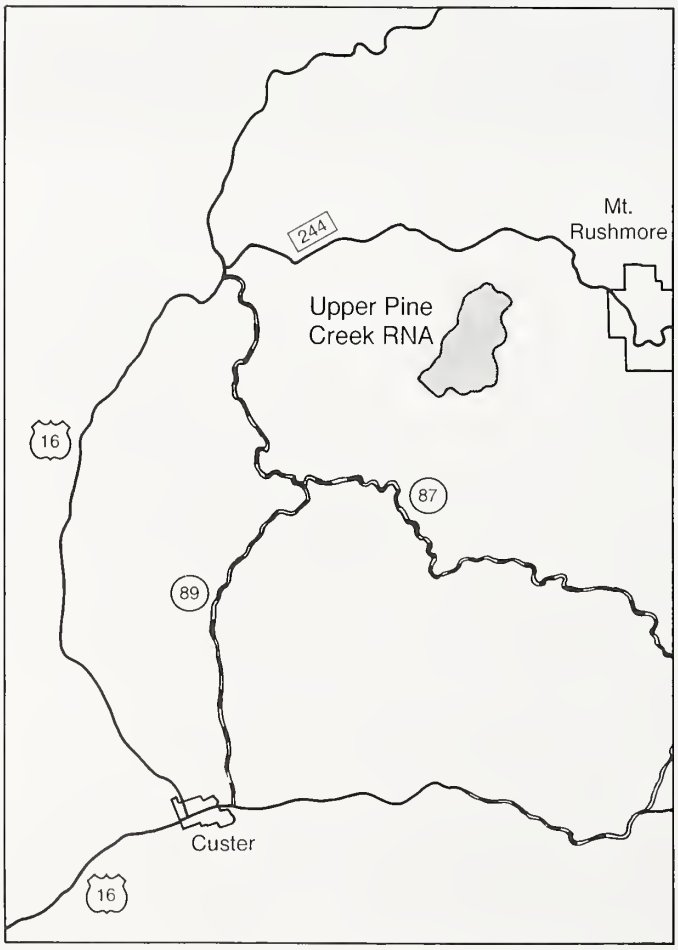

Figure 1. — Map of Upper Pine Creek RNA and vicinity.

Overview

This 482-hectare RNA is entirely contained within the Black Elk Wilderness Area, which is itself entirely within the Norbeck National Wildlife Preserve. One of the few roadless and ungrazed areas left in the Black Hills, the RNA is representative of the rugged high country on the flanks of the Harney Range (fig. 2) and is dominated by stands of ponderosa pine (*Pinus ponderosa*), mixed with white spruce (*Picea glauca*) and aspen (*Populus tremuloides*).

Climate

The average annual precipitation at the nearest weather station is 529 millimeters, and average annual temperature is 8°C (fig. 3). Average annual monthly maximum temperature is 14°C, and the average annual monthly minimum temperature is 2°C. The average frost-free period is from June 15 to August 15.

Physiography, Geology, and Soils

The elevation of this area, which sits on the north slope of Harney Peak at the top of the Pine Creek and Grizzly Bear Creek drainages, varies from 1829–2105 meters above sea level. The topography is extremely rough, and there are many huge granitic boulders, spires, and outcrops. The soil consists of Burska and Mocmont soils weathered from granite rock. The Mocmont soils are deep and well drained.

Flora

In a 1971 site visit, the dominant cover types were listed as: ponderosa pine, 364 hectares; and white spruce, 41 hectares. Aspen are scattered along the water courses. Dominant grasses are *Stipa*, *Elymus*, and *Agropyron*, and there are also several species of *Carex*. Prominent forbs are *Potentilla*, *Solidago*, and *Monarda*. Tall shrubs (*Salix*, *Cornus*, and *Corylus*) are present along the stream channels of both Grizzly Bear and Pine Creeks; such streamside vegetation is rare along many Black Hills streams, especially where they are grazed by livestock. Low shrubs (*Sym-*

Figure 2. — Upper Pine Creek RNA (photograph by John Lundquist).

phoricarpos and *Spiraea*) occur in the meadows. On drier upland sites, the understory is not as lush or as abundant. Where an understory does occur, kinnikinnick (*Arctostaphylos uvaursi*), timber oatgrass (*Danthonia intermedia*), and golden pea (*Thermopsis rhombifolia*) are the most common species, but they are sporadically distributed.

Fauna

The RNA lies entirely within the Norbeck National Wildlife Preserve. Big game species in the area include elk (*Cervus elaphus*), white-tailed deer (*Odocoileus virginianus*), and mountain goats (*Oreamnos americanus*).

Status and Administration

Upper Pine Creek RNA is managed under special management prescription 10A of the Black Hills National Forest Plan. The Harney Ranger District

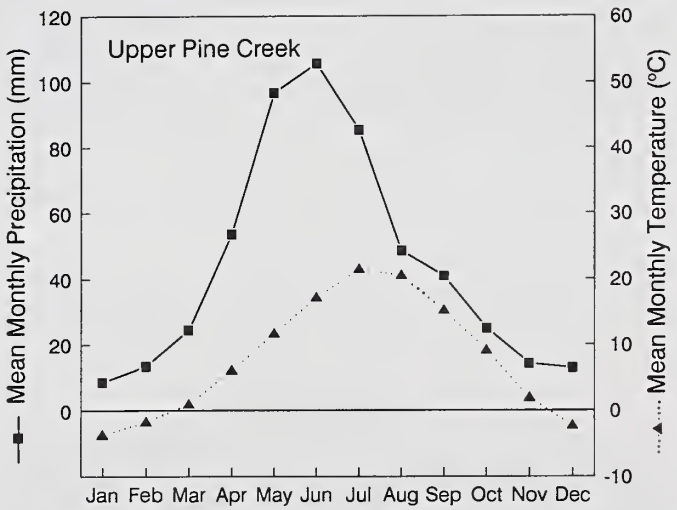

Figure 3. — Long-term average of mean monthly temperature and precipitation (from NOAA records) for the weather station closest to Upper Pine Creek RNA. Data were taken from the Mount Rushmore, SD, weather station, which is at an elevation of 1575 meters. The elevation of the RNA ranges from 1830–2105 meters, so actual climate at the RNA will likely be similar to that shown. Both precipitation and temperature were averaged over 30 years.

(Hill City, SD 57745, 605-574-2543) is responsible for administration and protection of the RNA.

For information on conducting research on the RNA, contact:

Research Natural Area Coordinator
Rocky Mountain Forest and Range
Experiment Station
240 West Prospect Road
Fort Collins, CO 80526-2098
(303) 498-1100

Research

Upper Pine Creek RNA is one of the few examples of undisturbed ponderosa pine forest in the Black Hills. As such, it represents a valuable control site for assessing the impacts of management. Black Hills RNA can also provide information about landscape patterns in unmanaged ponderosa pine forests.

Publications

Lundquist, J. E. 1991. Canopy gap profiles—a way to measure management impacts on forest ecosystems. In: Proceedings of the 6th International Congress of Plant Pathology. 1993, July 28-August 6, Montreal, Canada: p 124.

Lundquist, J. E. [In Press] Pest interactions and canopy gaps in ponderosa pine stands. In: Proceedings of the American Phytopathological Society Annual Meeting. 1993, November 6–10, Nashville, TN.

WILLIAMS CREEK RESEARCH NATURAL AREA

Location

Williams Creek RNA is northeast of Williams Creek Reservoir, about 20 air miles northwest of Pagosa Springs, Colorado, in Hinsdale County. It is situated within the Pagosa Ranger District, San Juan National Forest. The RNA occupies portions of sections 16 and 21, Township 38 North, Range 3 West, New Mexico Prime Meridian. The approximate center of the RNA is 37 31'14" North latitude, 107 11'43" West longitude.

Access to the RNA is via U.S. Highway 160 from Pagosa Springs to Forest Service Road 631 (the Piedra Road), just west of Pagosa Springs; then north on Forest Service Road 631 about 17 miles to Forest Service Road 636, which is about 1.5 miles north of the Piedra Picnic Ground (fig. 1). From the picnic ground, travel north on Forest Service Road 636 about 3.5 miles to Forest Service Road 638, a primitive road; then north and west on Forest Service Road 638 for about 4 miles to its dead-end at the eastern boundary of the RNA. There are no facilities or buildings at the end of Forest Service Road 638, and no roads or trails enter the RNA. To reach the RNA from Forest Service Road 640 and the Williams Creek reservoir area, hikers must ford Williams Creek and cross a half mile of rough brushland.

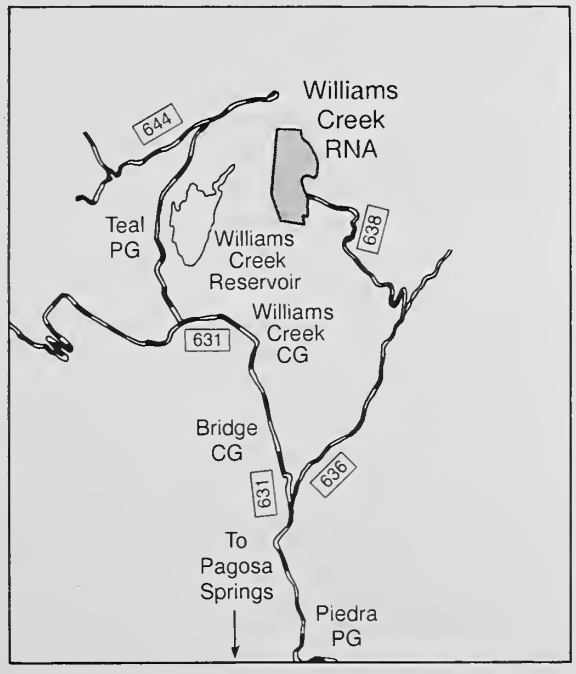

Figure 1. — Location of Williams Creek RNA.

Figure 2. — *Pinus strobiformis* and elderberry in white fir forest for Williams Creek RNA (photograph by Barry C. Johnston).

Overview

The Williams Creek RNA is characterized by large stands of white fir (*Abies concolor*), which comprise almost all of its 221 hectares. The forest within the RNA has apparently remained unmodified since settlement. The area occupies a glaciated bench between the valley of Williams Creek and the steep cliffs and outcrops that form the western boundary of the Weminuche Wilderness Area (fig. 2).

Climate

The area's climate is characterized by short, cool summers and long winters (fig. 3). June is the driest month; July and August are cool with frequent rain showers. The winter months are generally cold with heavy snow; the summer frost-free period ranges from 40–100 days. Average annual precipitation at Vallecito Dam, 22 miles southwest of Williams Creek Reservoir at an elevation of 2330 meters, is 662 millimeters; average annual temperature is 6°C.

Physiography, Geology, and Soils

The RNA is located on the eastern end of a broad, rolling, shallowly dissected bench between Williams Creek Reservoir and steep cliffs that form the lower slopes of an unnamed mountain, peak 11,462. The southeastern boundary of the RNA is near the hydrographic divide between the Middle Fork of the Rio Piedra and Williams Creek. Drainage is to the west via two permanent unnamed creeks that head near the eastern boundary of the RNA.

Elevation within the RNA ranges from 2545 meters at the northwest corner to 2940 meters on the ridges at the middle of the eastern boundary. Slopes in general range from 15–20%, but the range of slopes is wide. Within the RNA, the terrain is moderately dissected. The RNA's eastern edge is characterized by steeper, rockier slopes, as well as more open forests at the base of the cliffs.

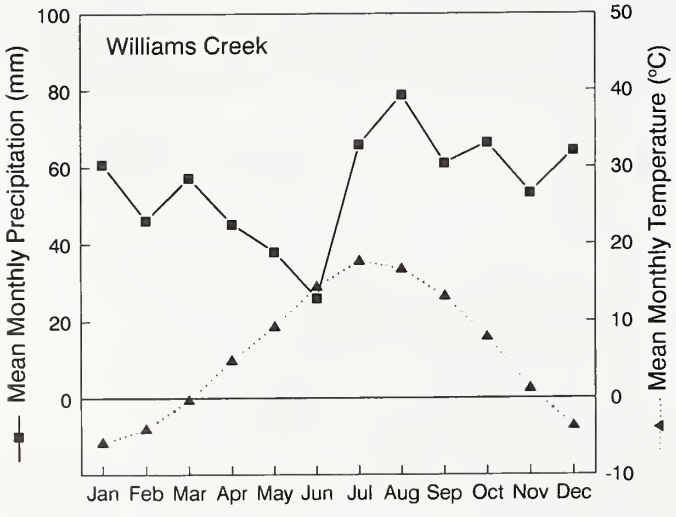

Figure 3. — Long-term average of monthly temperature and precipitation (from NOAA records) for the weather station closest to Williams Creek RNA. Data were taken from the Vallecito Dam, CO, weather station, which is at an elevation of 2330 meters. The elevation of the RNA ranges from 2545–2940 meters, so actual climate at the RNA will likely be quite different than that shown. Precipitation and temperature were averaged over 44 years.

The dissected bench that dominates the RNA is a glacial surface, and the western two-thirds of the area is a weathered moraine. This area is classified as glacial deposits of Quaternary age. The remainder of the RNA is classified as Conejos quartz latite, a moderately soft extensive lava flow of tuff and breccia beds of Miocene age. Soils are classified as Woodrock silt loam. Woodrock soils have a grayish-brown silt-loam A horizon averaging 254 millimeters thick, with dark brown clay loam to gravelly clay loam subsoils.

Flora

The entire RNA is forested, with the exception of a few acres of rock slides along the eastern boundary and two small boggy willow patches along the north creek. There are three major forested plant associations within the RNA—two within the white fir series, and one in the Engelmann spruce (*Picea engelmannii*) series:

1) White fir-Douglas-fir (*Pseudotsuga menziesii*)/forest fleabane (*Erigeron eximius*) plant association: 197 ha. This open, diverse white fir forest occurs on rolling terrain throughout the bench where the RNA is located. The canopies within the RNA are very mixed and multilayered. This plant association has many species of forbs, shrubs, and graminoids in the understory. Conspicuous species that are always present include bromes (*Bromus ciliatus* and *B. porteri*), sedges (*Carex geyeri* and *C. foenea*), Fendler meadowrue (*Thalictrum fendleri*), and violets (*Viola canadensis* and *V. adunca*). Aspen (*Populus tremuloides*) is often dominant in seral stands; ponderosa pine (*Pinus ponderosa*) is usually absent. Almost all of this area is in late seral to climax stages.
2) White fir-Douglas-fir/Rocky Mountain maple (*Acer glabrum*) plant association: 9 ha. This plant association has a similar overstory to white fir-Douglas-fir/forest fleabane, but with a somewhat more closed canopy. Shrubs are more conspicuous, especially Rocky Mountain maple, pachistima (*Pachistima myrsinites*), thimbleberry (*Rubus parviflorus*), Oregon grape (*Berberis repens*), and mountain snowberry (*Symphoricarpos oreophilus*). This type occurs more often on northerly slopes and on steeper slopes with shallower, better-drained soils. However, the tran-

sitions to white fir-Douglas-fir/forest fleabane can be gradual.

3) Engelmann spruce-grouse whortleberry (*Vaccinium scoparium*) plant association: 11 ha. This closed-canopy forest occurs in one medium-sized stand on a steep north slope on the upper, eastern side of the RNA. The stand is unusual because it occurs at a low elevation for its type and lacks subalpine fir (*Abies lasiocarpa*), except for a few individuals.

In addition to the plant associations listed above, there are 0.5 ha of Thurber fescue (*Festuca thurberi*)-Arizona fescue (*Festuca arizonica*), 1 ha of willow riparian area, and 2 ha of rocks, cliffs, and talus. Extensive plant lists for the RNA are included in the establishment record, which is on file at the Rocky Mountain Forest and Range Experiment Station in Fort Collins, Colorado.

Fauna

Elk (*Cervus elaphus*) and mule deer (*Odocoileus hemionus*) use the area as summer range; almost the entire RNA is in dense forest, mainly used for hiding cover. There are no threatened, endangered, or candidate animals known from the RNA or surrounding areas.

Mammals include pika (*Ochotona princeps*), snowshoe hare (*Lepus americanus*), yellow-footed marmot (*Marmota flaviventris*), golden-mantled ground squirrel (*Spermophilus lateralis*), Colorado chipmunk (*Tamias quadrivittatus*), red squirrel (*Tamiasciurus hudsonicus*), deer mouse (*Peromyscus maniculatus*), meadow vole (*Microtus pennsylvanicus*), porcupine (*Erethizon dorsatum*), red fox (*Vulpes vulpes*), coyote (*Canis latrans*), black bear (*Ursus americanus*), elk (*Cervus elaphus*), and mule deer (*Odocoileus hemionus*).

Birds found within the RNA include northern goshawk (*Accipiter gentilis*), Cooper's hawk (*Accipiter cooperii*), golden eagle (*Aquila chrysaetos*), great horned owl (*Bubo virginianus*), blue grouse (*Dendragapus obscurus*), hairy woodpecker (*Picoides villosus*), and Clark's nutcracker (*Nucifraga columbiana*). Amphibians found within the RNA include boreal chorus frog (*Pseudacris triseriata maculata*) and northern leopard frog (*Rana pipiens*).

Status and Administration

Williams Creek was designated a Research Natural Area in June 1987. It is managed under special management prescription 10A of the San Juan National Forest Plan. The Pagosa Ranger District (Pagosa Springs, CO 81147, 303-264-2268) is responsible for administration and protection of the RNA.

For information on conducting research on the RNA, contact:

Research Natural Area Coordinator
Rocky Mountain Forest and Range
Experiment Station
240 West Prospect Road
Fort Collins, CO 80526-2098
(303) 498-1100

Research and Publications

Williams Creek is suitable for research into the plants and animals of a white fir forest at late seral or near-climax stages. We found no published studies on the RNA.

*U.S. GOVERNMENT PRINTING OFFICE:1994-576-744/05144

Rocky Mountains

Southwest

Great Plains

U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

RESEARCH FOCUS

Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

RESEARCH LOCATIONS

Research Work Units of the Rocky Mountain Station are operated in cooperation with universities in the following cities:

Albuquerque, New Mexico
Flagstaff, Arizona
Fort Collins, Colorado*
Laramie, Wyoming
Lincoln, Nebraska
Rapid City, South Dakota

*Station Headquarters: 240 W. Prospect Rd., Fort Collins, CO 80526